

Technical Appendices: Citizens' panels on the role of future fuels in a low-carbon future energy mix in Australia

Project number: RP2.1-07.

Project title: Deliberative engagement processes on the role of future fuels in a low-carbon future energy mix in Australia

Authors:

Prof. Peta Ashworth, Dr Svetla Petrova, Dr Kathy Witt, Dr Belinda Wade, Bishal Bharadwaj, Elliot Clarke, Dr Katie Meissner & Dr Amrita Kambo

Project team:

Prof. Peta Ashworth
Dr Belinda Wade
Dr Kathy Witt
Dr Svetla Petrova
Dr Vicki Martin
Dr Amrita Kambo
Dr Katie Meissner
Bishal Bharadwaj
Mr Elliot Clarke

This work is funded by the Future Fuels CRC, supported through the Australian Government's Cooperative Research Centres Program. We gratefully acknowledge the cash and in-kind support from all our research, government and industry participants.



Australian Government
Department of Industry, Science,
Energy and Resources

Business
Cooperative Research
Centres Program

Important Disclaimer

Future Fuels CRC advises that the information contained in this report comprises statements based on research. Future Fuels CRC makes no warranty, express or implied, for the accuracy, completeness or usefulness of such information or represents that its use would not infringe privately owned rights, including any parties intellectual property rights. To the extent permitted by law, Future Fuels CRC (including its employees and Participants) excludes all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this report (in part or in whole) and any information or material contained in it.

© Copyright 2021 Future Fuels CRC. All Rights Reserved

Acknowledgement

This work is funded by the Future Fuels CRC, supported through the Australian Governments' Cooperative Research Centres Program. The cash and in-kind support from the industry participants is gratefully acknowledged.

The UQ research team gratefully acknowledges the following persons who have assisted in the project planning and delivery. The team is also indebted to all participants who shared their experiences, insights and opinions in the workshops and to all small group facilitators.

| | |
|-----------------------|-------------------------------------------------------|
| A/Prof Simon Smart | Dow Centre for Sustainable Engineering Innovation, UQ |
| Prof. Hugh Possingham | Queensland Chief Scientist |
| Alicia White | Energy Networks Australia |
| Greg Bourne | Climate Council, Australia |
| Lesley Dowling | Department of Science, Environment and Resources |
| Matt Walden | ARENA |
| Robyn Robinson | Council of the Aging, Queensland |
| Sabiene Heindl | Energy Charter |
| Steve Davies | Australian Pipeline and Gas Association |
| Greg Browning | CSIRO |
| Dr. Patrick Hartley | CSIRO |
| Prof. Peter Ashman | University of Adelaide |
| Dr. Tara Hosseini | University of Adelaide |
| Kellie Caught | Australian Council of Social Services |
| Andrew Harpham | Frontier Economics |
| Paul Gleeson | Aurecon |
| Dr. Nicola Willand | RMIT |
| Kate Hawke | Jemena |

Project Information

| | |
|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Project number | RP 2.1-07 |
| Project title | Deliberative engagement processes on the role of future fuels in the future low-carbon energy mix in Australia |
| Research Program | RP2 |
| Milestone Report Number | 2.3: Completion of all 3 deliberative engagement processes and interim report on the findings |
| Description | This report provides the findings of three deliberative processes conducted across Melbourne, Illawarra and South Australia in March, 2021. |
| Research Provider | University of Queensland |
| Project Leader and Team | Professor Peta Ashworth Dr Belinda Wade Dr Kathy Witt Dr Svetla Petrova Dr Vicki Martin Dr Katie Meissner Dr Amrita Kambo Bishal Bharadwaj Elliot Clarke |
| Industry Proponent and Advisor Team | James Turnley/James Cheong Holdaway - Jemena Guiliana Baggoley - EVO Kristen Pellew - AGIG Andrew Robertson/ Jordan McCollum - APGA Lynette Day - SA Gov Briony O'Shea - GPA Nives Matosin - APA David Counsell - AusNet Serv Peter Shaw - ATCO |
| Related Commonwealth Schedule | 2.1.3 Report on attitudes of the Australian society toward the risks and benefits of hydrogen as an energy carrier |
| Project start/completion date | August 2020/January 2022 |
| IP Status | Public Domain |
| Approved by | James Turnley |
| Date of approval | October 21, 2021 |

THIS PAGE INTENTIONALLY LEFT BLANK

Table of Contents

| | |
|-----------------------------------------------------------|-----------|
| Project Information | 4 |
| 1. Appendix: Questions via Deliberations | 7 |
| 2. Appendix: Survey to Citizen Panels | 11 |
| Pre-Deliberation | 11 |
| Feedback from Week 1 | 16 |
| Feedback from Week 2 | 18 |
| Post Deliberation | 20 |
| 3. Appendix: Presentations to Citizen Panels | 27 |

1. Appendix: Questions via Deliberations

Table 1. Highlighting the need for knowledge and awareness

| Theme | Questions from participants |
|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Climate, Climate Change, Extreme weather events, Emissions | At what degree do we have an extinction level event, and when would that hit if we made no changes to our current CO2 output? |
| | I saw that Brisbane used to record a temp of -2 deg several times a year, back in the not so distant past. Was this correct? |
| | Are we just in the end of an ice age or is something different occurring? |
| | With the rise in the sea levels is there also more variation between high and low tides? |
| | You demonstrated there appears to be a direct correlation between CO2 emission (and concentrations) and increasing temperatures, whilst CFCs, HFCs, Halons and Hydrocarbons have been phased out to a greater extent, do they have an impact upon temperature? |
| | With regards to the ozone layer, is this now part of the climate change banner or no longer an issue? is there a correlation between the close up of the ozone holes to increasing temperatures? |
| | Greg, can the BOM produce an up-to-date climate data service every night on the news? Australians need to know more about this. |
| | Can you elaborate on the CO2 parts per million, because we need around the 200 to survive, but then 1000 becomes extremely uncomfortable for humans. And that last part of the graph where it accelerates, and there were different color codes. Could you elaborate on what is actually happening? |
| | I was curious when you showed us that there will be less cyclonic activity or extreme cyclones in North Queensland in the future. And I'm wondering why? And how you get to that point, particularly as we say we're going to be getting more rain in those areas? |
| | I actually had a question about which was the bush fire graph. You had said change in number of dangerous fire days. What do you mean change to what compared to what? It just had colours, it didn't say like change compared to the last hundred years or anything like that? |
| | Government tells us one thing; energy companies tell us something else and the media laps up the confusion. Where do we go for real data on climate change, energy consumption and emissions? |
| | I was curious to know how we can spark change in industries as they are the biggest contributor of GHG. |
| | Interested in bio-energy. What is the trade off? What are the greater impacts of bio energy? i.e. burning rubbish to create energy. Seems like a win-win for decreasing landfill but I'm sure there is a trade-off. Good for the environment in having less landfill, but surely there is a climate impact? |
| | China had the Net Zero by 2060 right? I couldn't understand the graph, but above China was the colour blue which seemed to end at the same place. Does that mean that country had a Net Zero by 2060 as well? |
| Infrastructure | Just a quick question what is net zero 2050? |
| | How unavoidable are GHGEs anyway, after we're seeing not much difference between what's saved vs what's produced in all these processes? |
| Data source | On the graph that had Australia's carbon emissions, so on your graph you had a few things that I want to question. 'Fugitive emissions' - I didn't know what that was. The second question was that you had a little pink part of the talk with an acronym I'd never heard of. |
| | If the rain is falling in the NW and mainly running out to sea and it's drought in the SE and getting worse, why aren't we talking about a pipeline (a subject which goes back 50 years). |
| Pandemic | I was interested to know how they know data from 800 years ago. |
| Great Barrier Reef | With the graphs - on the graph scope you started to explain, shows data only from 1900 to now. Really they should go back for millennia... |
| | How did reduced travel (planes) effect the climate? |
| Fossil fuels | With things like the great barrier reef, in your opinion, is it likely that we'll be able to save that from disappearing in our lifetime or is that more than likely going to completely disappear and die. |
| | It concerns me, that over years and years there's been a lot of problems about. Now, they want to collect coal seam gas (CSG) in Queensland and damage the reef. CSG will kill the reef of eventually. Is this (ref: Presentation 1 – Decarbonisation pathway) going to negate the need for coal seam gas on the east coast of Australia, do you think Andrew? |
| | Where do Peak Oil and Coal get factored into the fossil fuel consumption spiral over the next 50 years? What about Peak oil and Coal? |

| Theme | Questions from participants |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | <p>If Australia supplies 2/3 of export coal/gas etc, to other countries and we stopped, what is the trade off?? They will get it elsewhere??</p> <p>The use of Hydrogen?? Isn't that dependent on fossil fuels anyway?</p> <p>What is clean coal? there is a lot of advertising from BHP around this.</p> <p>Do you have a formula that gives the amount of resistance power lines produce - how much extra coal is burnt just for the resistance</p> |
| Gas | <p>Is gas supplied to newly developed large residential areas?</p> |
| Renewable sources of energy (Wind, solar), Nuclear energy | <p>How much effort is being put into harnessing solar power as our main source of energy.</p> <p>Simon, what is the projection of Renewable energy by 2050?</p> <p>A question for Simon, what do you think is behind the main resistance to using nuclear.</p> <p>What is your opinion on the process of wastage from renewable technologies?</p> <p>Australia has its first solar car - why not look at that type of development in transport? Solar trucks, buses...maybe even trams?</p> <p>A graph projecting the price reduction of Batteries for energy storage. This will give people some idea as to when batteries may become cheap enough to be installed in residential houses.</p> |
| Biogas, Waste | <p>Isn't methane collected from landfills now?</p> <p>Are we able to train livestock to poo in a single location? Akin to people pooing in a toilet.</p> <p>Would it make more efficient the process to capture at least this portion of methane.</p> <p>Why not collect bio-gas from sewage?</p> <p>How does the plant deal with contamination ie plastics?</p> <p>does kitchen waste to green bin help a little or a lot?</p> <p>How much landfill waste is required to produce a kw of power?</p> <p>With the drive to reduce landfill waste, are we then wasting our time trying to use it for commercial power generation?</p> <p>At the domestic and rural level, why can't we generate our own methane from our own biomass?</p> |
| Deforestation, carbon capture, Carbon sequestration | <p>How many solar panels (MW) are required to compensate for the loss of CO2 uptake for the clearing of a std housing block of 1/4 acre. I think this data would be useful for people to understand the negative effects of land clearing.</p> <p>What are we as Australians doing as far as tree planting to replace the trees we have already removed. Maybe a yearly moving total of trees removed vs trees planted. Also, how much co2 is taken up by a young tree vs one that is established and fully grown.</p> <p>I wanted to know more about this carbon capture and is Australia sort of taking a lead on developing that that sort of technology about capturing carbon and sequestering it and all that?</p> |
| Hydrogen, Hydrogen economy, | <p>How much investment would be required in Hydrogen, and renewable energy options within our nation to reach the same output that coal, oil and LNG provides to provide raw energy for national use, not for export? Would this make a difference to meeting our net zero commitment?</p> <p>Does hydrogen production only supply 70% of the energy required to produce it?</p> <p>Just wanted to know who do we export to because I don't know if you actually mentioned that</p> <p>You sort of mentioned solar and wind are increasing in proportion. If that is the kind of the power that we will be using, where's the logic behind dropping hydrogen into the mix and having to start up a whole new industry, rather than expanding solar and wind?</p> <p>Question in relation to the exporting of the energy - Why?</p> <p>What's a Kg of hydrogen look like? What can it do?</p> <p>I don't understand why hydrogen would be easier or preferable to say battery storage?</p> <p>So, should we be investing in hydrogen over lithium?</p> <p>Could hydrogen fuel ever be used for aeroplanes?</p> <p>So, we are already paying extra for the diesel plant in NSW even though our dams are full... how much more are we going to pay to make the water to make the hydrogen they we will have to pay for as well....</p> <p>Are you looking at collecting the oxygen as well and using that in the combustion process to make it more efficient?</p> <p>How much electricity is used in the production of hydrogen - in units.</p> |

| Theme | Questions from participants |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | How far are we ready with our infrastructure to start using hydrogen as a future fuel - we ought to get our transport systems ready for hydrogen and we need to be quick with of course making hydrogen safest to use... |
| | Would be interesting to know how to get [hydrogen] available to homes? |
| | How is Australia doing comparing to its developed counterparts in looking to hydrogen as future fuel? |
| | Do you consider the total amount of energy required to produce the hydrogen, tanks, transport, etc., and where this energy is sourced? |
| | How soon do you think that hydrogen transport is going to be viable and will it be affordable for the lower socioeconomic society? |
| | [Hydrogen] Cost what are the hidden costs, and can we afford this? |
| | Is there really a chance that hydrogen could be economically feasible for us? |
| | Hydrogen] Does not have negative outputs - still needs energy to produce. [What are the] Dangers? |
| | What happens to the people that do not speak English and how do they learn about this [hydrogen]? |
| | The costs have fallen (as described by the presenter) but how does [hydrogen] compare to fossil fuels? |
| | Time factor how much time will it take for all this [hydrogen infrastructure] to be ready to take off |
| | In a high impact crash, would there be a huge explosion? Would it increase fatality? |
| | What happens to the water that would be produced during the splitting process by a passenger vehicle? |
| | [Hydrogen] Sounds too good to be true - why aren't we doing it? Cost to set up? Cost to run? If we aim for export will that make it more expensive for us? |
| | [Hydrogen] Safety what are we up for in relation to hydrogen and keeping the environment safe? |
| | How long does the steel pipeline infrastructure stay in prime condition for gas transport, eg H2. ie, how long before there are potential problems with gas leaks. |
| | Desalination plants. If we're using desalination plants for hydrogen production, what's the salt? Is it just the one byproduct, number one? And again, will that salt be used? Or is it pumped back in the ocean? Is that more concentrated? And secondly, if we're using cell plants for hydrogen production and taking water out of the sea does that help reduce the sea levels over time? |
| | I was just wondering if anyone could tell me, how long it would take to implement everything in completely? How long it's going to take to start getting this all implemented? I'm not 100% sure on the timeline of this? If we go ahead, how long it would actually take? |

Table 2. Highlighting the need for education, collaboration and consensus

| Theme | Questions from participants |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Social behaviour | I wonder what is the main driving factor that drives climate change denial. |
| Future generations | I am an educator... how do we educate the younger generations with all this complex information? |
| Conflict of interests | <p>Interesting to see two different options [hydrogen and biogas] being looked at also interesting to see how many people expect that the government has to supply/pay for everything. The question is, where is the money going to come from? How do we persuade our energy companies, mostly offshore, that what we decide, will be implemented? Getting them [companies] on board might be harder than getting the population to agree. How do we tell the natural gas industry that we can't afford two networks?</p> <p>How do you reflect on why, when you're working with Prime Minister such strong environmental issues are overtaken by the economic rationalism? And really what I'm trying to say is how with the energy transition future, we can avoid going down a similar path which is sort of the last chance since the last 30 years or so?</p> |
| Sharing responsibility | <p>If we build effective electricity networks, and efficient electrical appliances, and we have the option of solar generation for homes, then the issue of emission controls is left with the generators. Why not simply set emission targets on them and let market forces decide the best solution?</p> <p>Why can't tenants be just as responsible as landlords? And why can't tenants be made to highlight problems with their properties, but to be responsible for energy in their properties.</p> <p>Nicola, you mentioned something about rental properties - that our landlords should do their part to ensure that they promised the rental property is properly insulated, which is good. However, it costs a lot of money to maintain your property, so do you think that landlord should be compensated by people?</p> |
| Expanding knowledge networks | <p>What can we learn from our indigenous people? They seem to have coped for tens of thousands of years and preserved their environment.</p> <p>It almost seems like throughout the whole journey of hydrogen, it seems as though Australia, the narrative again is that we're trying to reinvent the wheel almost and we've got to do everything from scratch But there are other parts of the world where that have also gone on this journey and it's not a national problem. It's not a state problem, it's a global problem. So why isn't there more collaboration?</p> |

Table 3. Highlighting the need for dignity of life, wealth, health and well-being

| Theme | Questions from participants |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Quality of life | I have a question about your quality of life graph, which was the Human Development Index versus carbon emissions so you had various countries on the lower end like Niger, Sri Lanka, Sweden on there, higher than China, USA, but a notable admission was Australia, where do we fit on that graph? |
| Economic and social welfare | <p>Will the changes cause more poverty down the track?</p> <p>Centring on when department of housing comes into the picture and help seniors? Again, no higher income support to help them and mitigate their energy problems.</p> <p>And see, for instance, also can it also happen that enormous companies as Harvey Norman, Kmart, Big W and the Good Guys come in and donate electric fans?</p> <p>What are retrofit subsidies and the percentages for the various states that you referred to? The level of subsidies or like the number of properties were horrible that are being targeted.</p> <p>It seems like it's a time of large social change and technological change. Is it time to sort of look at the idea again of a living wage for people? So, people who are left out, those people can actually live?</p> <p>Do you know the shopping malls - just so it is more sort of friendly? (Do you know shopping malls) are, you know sort of helpful for the older people, especially ?</p> |

2. Appendix: Survey to Citizen Panels

Please note the scales in the survey questions were reversed during the analysis to make them consistent with previous surveys.

PRE-DELIBERATION

Unique Identifier Code

To start with, please create your **Unique Identifier Code**, which keeps your answers anonymous while facilitating the reflective diary process. To do so, enter:

First TWO (2) LETTERS of your mother's name*:

Last TWO (2) DIGITS of your phone number:

*or other significant person in your life. Remember who this is for the next diary entry.

For example, my mother was Mary and the last two digits of my phone number are 09. My unique code would be MA09.

Please write this down and keep it in a safe place, as you will need this code again.

Citizen Information

Please complete the following:

Your age: Your postcode:

What is your Gender?

- Male
- Female
- Transgender Female
- Transgender Male
- Gender variant/ non-conforming
- Not listed
- Prefer not to answer

Household Energy Use

| Do you use the following in your household? | Y/N |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> • Electricity (grid connected) • Gas (mains) • Gas (bottled) • Solar hot water • Solar PV (e.g. rooftop panels) • Battery storage unit • Battery electric vehicle • Hybrid vehicle • Others (please specify) | |
| Do you subscribe to renewable energy (sometimes called GreenPower) from your electricity provider? | Y/N |
| How strongly do you agree or disagree with the use of the following energy sources and related technologies as potential ways of generating Australia's future energy needs? | |
| Strongly agree | Agree |
| Somewhat agree | Neither agree nor disagree |
| Somewhat disagree | Disagree |
| Strongly disagree | |
| <ul style="list-style-type: none"> • Hydrogen • Coal • Gas • Gas or coal with carbon capture and storage • Wind | <ul style="list-style-type: none"> • Solar PV • Oil (e.g. diesel/petrol for transport) • Nuclear (for power) • Biomass |

Below are some statements about energy sources and priorities for Australia:

Please indicate how close each statement is to your own point of view against the scale below.

| Strongly aligned with my point of view | Moderately aligned | Slightly aligned | Neither (neutral) | Slightly against | Moderately against | Strongly against my point of view |
|----------------------------------------|--------------------|------------------|-------------------|------------------|--------------------|-----------------------------------|
|----------------------------------------|--------------------|------------------|-------------------|------------------|--------------------|-----------------------------------|

- Australia should focus on renewables, even if we need to invest more in infrastructure to make the system more reliable
- Australia should focus on renewables but in the meanwhile continue to use gas as a transition fuel to make the transition smooth and affordable
- Australia should focus on traditional energy sources such as coal & gas, even if the environment suffers to some extent
- Australia should focus on traditional energy sources such as coal & gas in a post-COVID environment to allow for economic recovery

What are the three (3) most important considerations you think Australia needs to make now to transition towards a low-carbon energy future?

- | | |
|-----------------|-----------------|
| • Political | • Technological |
| • Environmental | • Economic |
| • Social | • Cultural |
| • Behavioral | • Other |

Below are some statements about energy export and priorities for Australia.

Please indicate how close each statement is to your own point of view against the scale below.

| Strongly aligned with my point of view | Moderately aligned | Slightly aligned | Neither (neutral) | Slightly against | Moderately against | Strongly against my point of view |
|----------------------------------------|--------------------|------------------|-------------------|------------------|--------------------|-----------------------------------|
|----------------------------------------|--------------------|------------------|-------------------|------------------|--------------------|-----------------------------------|

- Australia should continue to export coal to developing countries, to help them reduce poverty and develop their economies
- Australia has an abundant supply of fossil fuels and we should continue to export them to keep our economy strong
- Australia should develop a renewable energy industry for export (such as hydrogen), to help other countries reduce their carbon emissions
- Australia should continue to export fossil fuels to keep our economy strong in a post-COVID environment and use some of the profits to establish renewable energy industry for export

Energy policy can involve difficult trade-offs between the economy and the environment.

Which one (1) of the following statements best describes your view?

- The highest priority should be given to protecting the environment, even if it hurts the economy.
- Both the environment and the economy are important, but the environment should come first.
- Both the environment and the economy are important and balancing the two should be the highest priority.
- Both the environment and the economy are important, but the economy should come first.
- The highest priority should be given to economic considerations even if it hurts the environment.

The following questions are about using hydrogen for energy. Do not worry if you don't know much about hydrogen. Please answer the questions as best you can.

Please indicate how close each statement is to your own point of view against the scale below.

| I have never heard of it | I have heard of it | I know about it and could describe it to a friend |
|--------------------------|--------------------|---------------------------------------------------|
|--------------------------|--------------------|---------------------------------------------------|

- How hydrogen is produced
- The use of hydrogen fuel cells in vehicles
- The use of hydrogen fuel cells in homes
- Hydrogen as an energy storage medium for electricity
- Hydrogen refueling stations
- Burning hydrogen as a replacement for natural gas

At this point, how do you feel about hydrogen as a possible solution for energy and environmental challenges?

- Very supportive
- Supportive
- Slightly supportive
- Neither supportive nor unsupportive
- Slightly unsupportive
- Unsupportive
- Very unsupportive

[If *Neither supportive nor unsupportive* is selected:]

Why did you select "Neither supportive nor unsupportive" for hydrogen as a possible solution for energy and environmental challenges?

- I do not know enough about hydrogen to decide
- I do not have any feelings either way (positive or negative)
- There are pros and cons of hydrogen, which makes my support neutral
- I did not understand the question
- I have no opinion on this issue
- I don't care
- Other reason (please specify):

If hydrogen were available today, how willing would you be to use it in your home for the following uses?

| Very willing | Moderately willing | Slightly willing | Neither willing nor unwilling | Slightly unwilling | Moderately unwilling | Very unwilling |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|------------------|-------------------------------|--------------------|----------------------|----------------|
| <ul style="list-style-type: none"> • On-site electricity generation • Cooking • Using natural gas that contains some hydrogen (i.e. a blend) • For driving hydrogen fuel cell electric vehicles • Hot water heating • Space heating | | | | | | |

Overall, do you think using hydrogen for energy in Australia would be:

| | +3 | +2 | +1 | 0 | -1 | -2 | -3 | |
|-------------------|----|----|----|---|----|----|----|------------------|
| very worthwhile | | | | | | | | very worthless |
| very useful | | | | | | | | very useless |
| very beneficial | | | | | | | | very harmful |
| a very good thing | | | | | | | | a very bad thing |

When you think about the use of hydrogen in Australia, please indicate how it makes you feel:

| | +3 | +2 | +1 | 0 | -1 | -2 | -3 | |
|----------------|----|----|----|---|----|----|----|------------------|
| very calm | | | | | | | | very angry |
| very proud | | | | | | | | very embarrassed |
| very inspired | | | | | | | | very uninspired |
| very happy | | | | | | | | very sad |
| Very concerned | | | | | | | | Very unconcerned |

If a hydrogen economy was to be developed in Australia, to what extent do you agree or disagree that the following groups would act in the best interest of the consumer?

| Strongly agree | Agree | Somewhat agree | Neither agree nor disagree | Somewhat disagree | Disagree | Strongly disagree |
|----------------|-------|----------------|----------------------------|-------------------|----------|-------------------|
|----------------|-------|----------------|----------------------------|-------------------|----------|-------------------|

- Federal government
- State government
- Local government
- Electricity generation companies
- Fuel/gas supply companies
- Car/appliance manufacturers
- Universities
- CSIRO
- Media
- Environmental Non-Government Organizations (ENGOS)

Do you believe climate change is happening now or will happen in the next 30 years?

- Yes, it is already happening
- It will start happening within the next 30 years
- No, it is not happening and won't
- I do not know/ I am not sure

How convinced are you that climate change represents a real problem for Australia?

- Very convinced
- Convinced
- Slightly convinced
- Neither convinced nor unconvinced
- Slightly unconvinced
- Unconvinced
- Very unconvinced

Demographics

Which best describes your highest level of education you have completed?

- Year 10 or below
- Year 11 or equivalent
- Year 12 or equivalent
- Trade certificate or Apprenticeship
- Certificate I or II
- Certificate III or IV
- Advanced Diploma / Diploma
- Bachelor or Honours degree
- Postgraduate degree (e.g. Masters, PhD)
- Other (please specify)

Which of the following best describes your occupational status?

- Student
- Household duties
- Employed – Part Time
- Employed – Full Time
- Unemployed not looking for work
- Unemployed looking for work
- Retired
- Not able to work
- Other (please specify)

Which occupational sector do you work in (or worked in prior to ceasing work)?

- | | |
|---------------------------------------------|------------------------------------------------|
| • Agriculture, forestry, fishing | • Financial and Insurance services |
| • Mining | • Rental, hiring and real estate services |
| • Manufacturing | • Professional, scientific, technical services |
| • Electricity, gas, water, waste services | • Administrative and support workers |
| • Construction | • Public administration and safety |
| • Wholesale trade | • Education and training |
| • Retail trade | • Health care and social assistance |
| • Accommodation and food services | • Arts and recreation services |
| • Transport, postal and warehousing | • Other services |
| • Information, media and telecommunications | • Not applicable |

In which country were you born?

- | | |
|-------------|--------------------------|
| • Australia | • New Zealand |
| • England | • Philippines |
| • India | • Scotland |
| • Italy | • South Africa |
| • Malaysia | • Vietnam |
| | • Other - please specify |

Are you of Aboriginal or Torres Strait Islander origin?

- No
 - Yes, Aboriginal
 - Yes, Torres Strait Islander
-

FEEDBACK FROM WEEK 1

Please note the scales in the survey questions were reversed during the analysis to make them consistent with previous surveys.

Unique Identifier Code

To start with, please create your **Unique Identifier Code**, which keeps your answers anonymous while facilitating the reflective diary process. To do so, enter:

First TWO (2) LETTERS of your mother's name*:

Last TWO (2) DIGITS of your phone number:

*or other significant person in your life. Remember who this is for the next diary entry.

For example, my mother was Mary and the last two digits of my phone number are 09. My unique code would be MA09.

Please write this down and keep it in a safe place, as you will need this code again.

Feedback Form

After listening to the presentations and talking to other members of your community, to what extent did you find you changed or broadened your views about climate change and energy as a result of this week's workshops?

- | | |
|----------------------------|---------------------|
| • To a great extent | • To a small extent |
| • To a fairly great extent | • Not at all |
| • To a moderate extent | |

How well did you feel you were able to:

| Extremely well | Very well | Moderately well | Slightly well | Not well at all |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------|---------------|-----------------|
| <ul style="list-style-type: none"> Understand the purpose of the research Understand your role in the research Understand the key issues under discussion Learn about the issues that were discussed in the breakout rooms Listen to what others in your breakout room have to say about the topics under discussion Express your own views on the topics under discussion in the breakout rooms | | | | |

How much do you believe that:

| Definitely | To a large extent | To a moderate extent | To a small extent | None at all |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|----------------------|-------------------|-------------|
| <ul style="list-style-type: none"> Your participation was encouraged by the breakout room facilitator Your contribution was valued and respected by the other participants in your breakout room The discussions in your breakout room resulted in useful conclusions and outcomes | | | | |

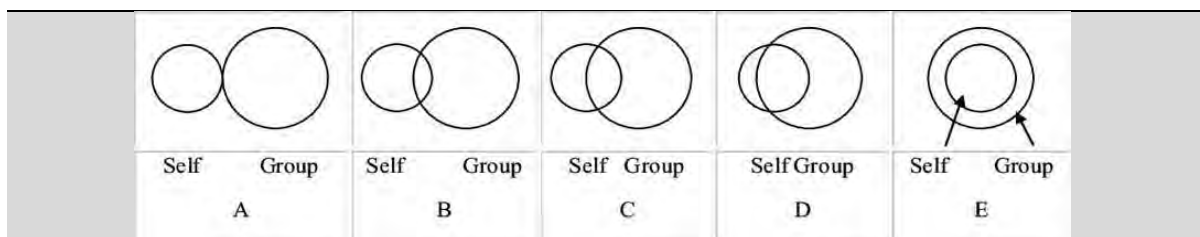
Your overall experience with the presentation on Climate Change:

| Strongly agree | Tend to agree | Neither agree nor disagree | Somewhat disagree | Strongly disagree |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------------------------|-------------------|-------------------|
| <ul style="list-style-type: none"> I understood everything that was presented by the speaker I trusted what the speaker said The information presented by the speaker was relevant and helpful to the small group discussions. | | | | |

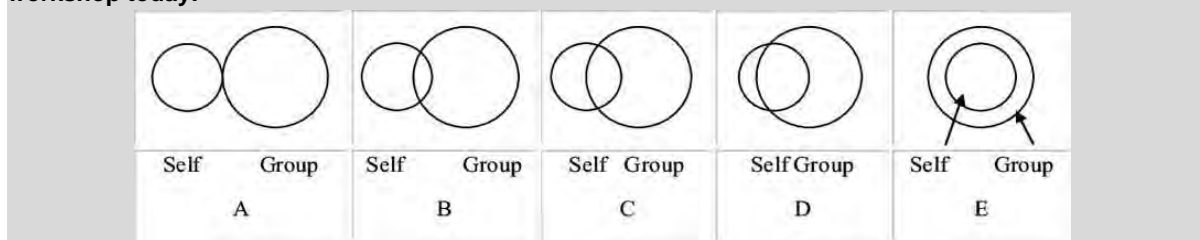
Your overall experience with the presentation on Energy:

| Strongly agree | Tend to agree | Neither agree nor disagree | Somewhat disagree | Strongly disagree |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------------------------|-------------------|-------------------|
| <ul style="list-style-type: none"> I understood everything that was presented by the speaker I trusted what the speaker said The information presented by the speaker was relevant and helpful to the small group discussions. | | | | |

If the circle on the left represents you and the circle on the right represents people in your breakout room, select the diagram that best describes your relationship with the other fellow citizens in your breakout room:



If the circle on the left represents you and the circle on the right represents all the people in workshop, select the diagram that best describes your relationship with the other fellow citizens that attended the workshop today:



Do you have any comments or suggestions that you would like to share with us?

FEEDBACK FROM WEEK 2

Please note the scales in the survey questions were reversed during the analysis to make them consistent with previous surveys.

Unique Identifier Code

To start with, please create your **Unique Identifier Code**, which keeps your answers anonymous while facilitating the reflective diary process. To do so, enter:

First TWO (2) LETTERS of your mother's name*:

Last TWO (2) DIGITS of your phone number:

*or other significant person in your life. Remember who this is for the next diary entry.

For example, my mother was Mary and the last two digits of my phone number are 09. My unique code would be MA09.

Please write this down and keep it in a safe place, as you will need this code again.

Citizen Information

Please complete the following:

Your age:

Your postcode:

Which state do you live in?

- New South Wales
- South Australia
- Victoria
- Another state

What is your Gender?

- Male
- Female
- Transgender Female
- Transgender Male
- Gender variant/ non-conforming
- Not listed
- Prefer not to answer

Feedback Form

After listening to the presentations and talking to other members of your community, to what extent did you find you changed or broadened your views about future fuels and the social implications of a low-carbon energy transition as a result of this week's workshops

- To a great extent
- To a fairly great extent
- To a moderate extent
- To a small extent
- Not at all

How well did you feel you were able to:

| Extremely well | Very well | Moderately well | Slightly well | Not well at all |
|----------------|-----------|-----------------|---------------|-----------------|
|----------------|-----------|-----------------|---------------|-----------------|

- Understand the key issues under discussion
- Learn about the issues that were discussed in the breakout rooms
- Listen to what others in your breakout room have to say about the topics under discussion
- Express your own views on the topics under discussion in the breakout rooms

How much do you believe that:

| Definitely | To a large extent | To a moderate extent | To a small extent | None at all |
|------------|-------------------|----------------------|-------------------|-------------|
|------------|-------------------|----------------------|-------------------|-------------|

- Your participation was encouraged by the breakout room facilitator
- Your contribution was valued and respected by the other participants in your breakout room
- The discussions in your breakout room resulted in useful conclusions and outcomes

Your overall experience with the presentation on Future Fuels:

| | | | | |
|----------------|---------------|----------------------------|-------------------|-------------------|
| Strongly agree | Tend to agree | Neither agree nor disagree | Somewhat disagree | Strongly disagree |
|----------------|---------------|----------------------------|-------------------|-------------------|

- I understood everything that was presented by the speaker
- I trusted what the speaker said
- The information presented by the speaker was relevant and helpful to the small group discussions.

Your overall experience with the presentation on Bio Fuels:

| | | | | |
|----------------|---------------|----------------------------|-------------------|-------------------|
| Strongly agree | Tend to agree | Neither agree nor disagree | Somewhat disagree | Strongly disagree |
|----------------|---------------|----------------------------|-------------------|-------------------|

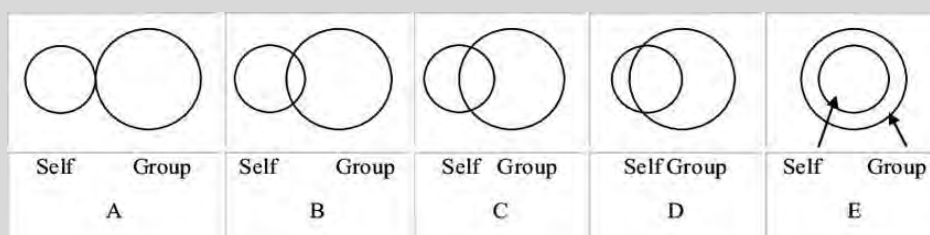
- I understood everything that was presented by the speaker
- I trusted what the speaker said
- The information presented by the speaker was relevant and helpful to the small group discussions.

Your overall experience with the presentation Social implications and consumers' perspective:

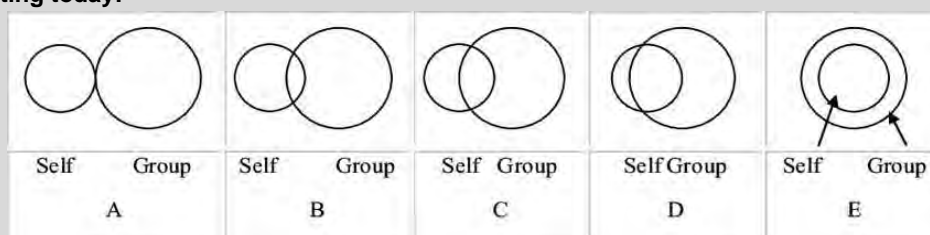
| | | | | |
|----------------|---------------|----------------------------|-------------------|-------------------|
| Strongly agree | Tend to agree | Neither agree nor disagree | Somewhat disagree | Strongly disagree |
|----------------|---------------|----------------------------|-------------------|-------------------|

- I understood everything that was presented by the speaker
- I trusted what the speaker said
- The information presented by the speaker was relevant and helpful to the small group discussions.

If the circle on the left represents you and the circle on the right represents people in your breakout room, select the diagram that best describes your relationship with the other fellow citizens in your breakout room:



If the circle on the left represents you and the circle on the right represents all the people in workshop, select the diagram that best describes your relationship with the other fellow citizens that attended the Zoom meeting today:



| | | | | |
|---|---|---|---|---|
| A | B | C | D | E |
|---|---|---|---|---|

Do you have any comments or suggestions that you would like to share with us?

POST DELIBERATION

Please note the scales in the survey questions were reversed during the analysis to make them consistent with previous surveys.

Unique Identifier Code

To start with, please create your **Unique Identifier Code**, which keeps your answers anonymous while facilitating the reflective diary process. To do so, enter:

First TWO (2) LETTERS of your mother's name*:

Last TWO (2) DIGITS of your phone number:

*or other significant person in your life. Remember who this is for the next diary entry.

For example, my mother was Mary and the last two digits of my phone number are 09. My unique code would be MA09.

Please write this down and keep it in a safe place, as you will need this code again.

Citizen Information

Please complete the following:

Your age:

Your postcode:

Which state do you live in?

- New South Wales
- South Australia
- Victoria
- Another state

What is your Gender?

- Male
- Female
- Transgender Female
- Transgender Male
- Gender variant/ non-conforming
- Not listed
- Prefer not to answer

Energy Perceptions

How strongly do you agree or disagree with the use of the following energy sources and related technologies as potential ways of generating Australia's future energy needs?

| Strongly agree | Agree | Slightly agree | Neither agree nor disagree | Slightly disagree | Disagree | Strongly disagree |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------------|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------|
| <ul style="list-style-type: none"> • Hydrogen • Coal • Gas • Gas or coal with carbon capture and storage • Wind | | | | <ul style="list-style-type: none"> • Solar PV • Oil (e.g. diesel/petrol for transport) • Nuclear (for power) • Biomass | | |

Below are some statements about energy sources and priorities for Australia:

Please indicate how close each statement is to your own point of view

| Strongly aligned with my point of view | Moderately aligned | Slightly aligned | Neither (neutral) | Slightly against | Moderately against | Strongly against my point of view |
|----------------------------------------|--------------------|------------------|-------------------|------------------|--------------------|-----------------------------------|
|----------------------------------------|--------------------|------------------|-------------------|------------------|--------------------|-----------------------------------|

- Australia should focus on renewables, even if we need to invest more in infrastructure to make the system more reliable
- Australia should focus on renewables but in the meanwhile continue to use gas as a transition fuel to make the transition smooth and affordable
- Australia should focus on traditional energy sources such as coal & gas, even if the environment suffers to some extent
- Australia should focus on traditional energy sources such as coal & gas in a post-COVID environment to allow for economic recovery

What are the three (3) most important considerations you think Australia needs to make now to transition towards a low-carbon energy future?

- Political
- Environmental
- Social
- Behavioral
- Technological
- Economic
- Cultural
- Other

Below are some statements about energy export and priorities for Australia:

Please indicate how close each statement is to your own point of view

| Strongly aligned with my point of view | Moderately aligned | Slightly aligned | Neither (neutral) | Slightly against | Moderately against | Strongly against my point of view |
|----------------------------------------|--------------------|------------------|-------------------|------------------|--------------------|-----------------------------------|
|----------------------------------------|--------------------|------------------|-------------------|------------------|--------------------|-----------------------------------|

- Australia should continue to export coal to developing countries, to help them reduce poverty and develop their economies
- Australia has an abundant supply of fossil fuels and we should continue to export them to keep our economy strong
- Australia should develop a renewable energy industry for export (such as hydrogen), to help other countries reduce their carbon emissions
- Australia should continue to export fossil fuels to keep our economy strong in a post-COVID environment and use some of the profits to establish renewable energy industry for export

Energy policy can involve difficult trade-offs between the economy and the environment.

Which one (1) of the following statements best describes your view?

- The highest priority should be given to protecting the environment, even if it hurts the economy.
- Both the environment and the economy are important, but the environment should come first.
- Both the environment and the economy are important and balancing the two should be the highest priority.
- Both the environment and the economy are important, but the economy should come first.
- The highest priority should be given to economic considerations even if it hurts the environment.

How much do you know about the following?

| I have never heard of it | I have heard of it | I know about it and could describe it to a friend |
|--------------------------|--------------------|---------------------------------------------------|
|--------------------------|--------------------|---------------------------------------------------|

- How hydrogen is produced
- The use of hydrogen fuel cells in vehicles
- The use of hydrogen fuel cells in homes
- Hydrogen as an energy storage medium for electricity
- Hydrogen refuelling stations
- Burning hydrogen as a replacement for natural gas

Overall, how do you feel about hydrogen as a possible solution for energy and environmental challenges?

- Very supportive
- Supportive
- Slightly supportive
- Neither supportive nor unsupportive
- Slightly unsupportive
- Unsupportive
- Very unsupportive

[If *Neither supportive nor unsupportive* is selected:]

What is the main reason you selected *Neither supportive nor unsupportive* for hydrogen as a possible solution for energy and environmental challenges?

- I do not know enough about hydrogen to decide
- I do not have any feelings either way (positive or negative)
- There are pros and cons of hydrogen, which makes my support neutral
- I did not understand the question
- I have no opinion on this issue
- I don't care
- Other reason (please specify)

If hydrogen were available today, how willing would you be to use it in your home for the following uses?

| Very willing | Moderately willing | Slightly willing | Neither willing nor unwilling | Slightly unwilling | Moderately unwilling | Very unwilling |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|------------------|-------------------------------|--------------------|----------------------|----------------|
| <ul style="list-style-type: none"> • On-site electricity generation • Cooking • Using natural gas that contains some hydrogen (i.e. a blend) • For driving hydrogen fuel cell electric vehicles • Hot water heating • Space heating | | | | | | |

Overall, do you think using hydrogen for energy in Australia would be:

| | +3 | +2 | +1 | 0 | -1 | -2 | -3 | |
|-------------------|----|----|----|---|----|----|----|------------------|
| very worthwhile | | | | | | | | very worthless |
| very useful | | | | | | | | very useless |
| very beneficial | | | | | | | | very harmful |
| a very good thing | | | | | | | | a very bad thing |

When you think about the use of hydrogen in Australia, please indicate how it makes you feel:

| | +3 | +2 | +1 | 0 | -1 | -2 | -3 | |
|----------------|----|----|----|---|----|----|----|------------------|
| very calm | | | | | | | | very angry |
| very proud | | | | | | | | very embarrassed |
| very inspired | | | | | | | | very uninspired |
| very happy | | | | | | | | very sad |
| Very concerned | | | | | | | | Very unconcerned |

If a hydrogen economy was to be developed in Australia, to what extent do you agree or disagree that the following groups would act in the best interest of the consumer?

| Strongly agree | Agree | Somewhat agree | Neither agree nor disagree | Somewhat disagree | Disagree | Strongly disagree |
|----------------|-------|----------------|----------------------------|-------------------|----------|-------------------|
|----------------|-------|----------------|----------------------------|-------------------|----------|-------------------|

- Federal government
- State government
- Local government
- Electricity generation companies
- Fuel/gas supply companies
- Car/appliance manufacturers
- Universities
- CSIRO
- Media
- Environmental Non-Government Organizations (ENGOS)

Do you believe climate change is happening now or will happen in the next 30 years?

- Yes, it is already happening
- It will start happening within the next 30 years
- No, it is not happening and won't
- I do not know/ I am not sure

How convinced are you that climate change represents a real problem for Australia?

- Very convinced
- Convinced
- Slightly convinced
- Neither convinced nor unconvinced
- Slightly unconvinced
- Unconvinced
- Very unconvinced

To what extent do you agree or disagree with the following statements?

| Strongly agree | Agree | Slightly agree | Neither agree nor disagree | Slightly disagree | Disagree | Strongly disagree |
|----------------|-------|----------------|----------------------------|-------------------|----------|-------------------|
|----------------|-------|----------------|----------------------------|-------------------|----------|-------------------|

- I should be consulted regularly about hydrogen developments in my local area
- I should be consulted regularly about hydrogen developments elsewhere in Australia
- I feel confident others in my community will make the right decisions about hydrogen developments in my local area
- I feel confident others in the Australian community will make the right decisions about hydrogen developments elsewhere in Australia

Next, think about the community you live in and how it might respond to the idea of using hydrogen.

How much do you think your community would accept or reject hydrogen as an energy source for the following uses:

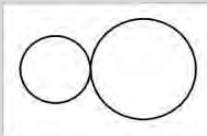
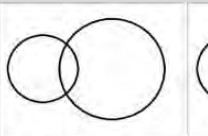
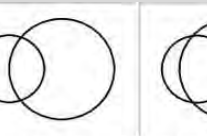
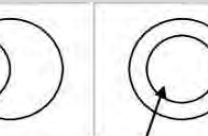
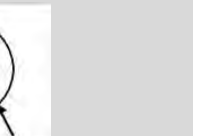
| Strongly accept | Moderately accept | Slightly accept | Neither accept nor reject | Slightly reject | Moderately reject | Strongly reject |
|-----------------|-------------------|-----------------|---------------------------|-----------------|-------------------|-----------------|
|-----------------|-------------------|-----------------|---------------------------|-----------------|-------------------|-----------------|

- Household electricity generation (onsite)
- Cooking
- Using natural gas that contains some hydrogen (i.e. a blend)
- Hot water heating
- Space heating
- Private vehicles (i.e. hydrogen fuel cell electric vehicles)
- Public transport
- Industrial use
- International export

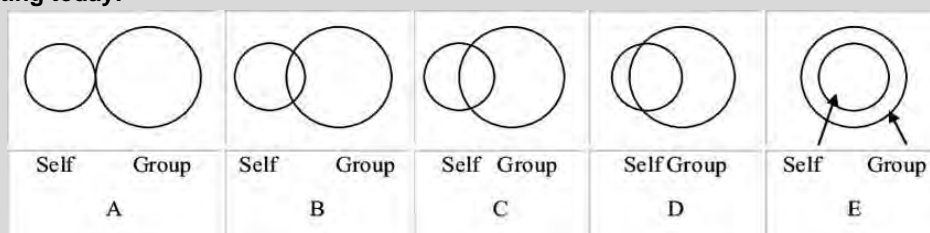
| Other Questions | | | | | | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----------------|-----------------------------|-------------------|---------------------|----------------------|
| Have you done the following activities previously? | | | | | | Yes/No |
| <ul style="list-style-type: none"> I have attended protests I have engaged with local community groups about political issues I have signed petitions I often submit my views to my government member I have volunteered to make people's lives better I have done other activities to contribute to my community | | | | | | |
| How likely are you to undertake any of the following activities in the future? | | | | | | |
| Extremely likely | Moderately likely | Slightly likely | Neither likely nor unlikely | Slightly unlikely | Moderately unlikely | Extremely unlikely |
| <ul style="list-style-type: none"> Attend protests Engage with local community groups about political issues Sign petitions Submit my views to my government member Volunteer to make people's lives better Do other activities to contribute to my community | | | | | | |
| Now, think about your experiences in the citizen panel for this project. | | | | | | Yes/No/Unsure |
| Did your experiences in the citizens panels change the way you feel about taking part in any community or volunteer actions in the future?? | | | | | | |
| If yes, In what way did your feelings change? | | | | | | |
| Please indicate how much you agree or disagree with the following statements? | | | | | | |
| Strongly agree | Agree | Somewhat agree | Neither agree nor disagree | Somewhat disagree | Disagree | Strongly disagree |
| <ul style="list-style-type: none"> I used information from the speakers and videos when I presented my views to the group I felt others used information from the speakers and videos when they presented their views to the group I felt included in the group discussions I felt the other citizens in my panel generally represented the rest of the population in my region My views and opinions toward hydrogen were treated with respect The views of others were also treated with respect Most people's opinions were driven by self interest Most people's opinions were driven by what was best for the community/others | | | | | | |
| Feedback Form | | | | | | |
| After listening to the presentations and talking to other members of your community, to what extent did you find you changed or broadened your views about low-carbon energy transitions and the possible pathways as a result of this week's workshops? | | | | | | |
| <ul style="list-style-type: none"> To a great extent To a fairly great extent To a moderate extent To a small extent Not at all | | | | | | |
| How well did you feel you were able to: | | | | | | |
| Extremely well | Very well | Moderately well | Slightly well | Not well at all | | |
| <ul style="list-style-type: none"> Understand the key issues under discussion Learn about the issues that were discussed in the breakout rooms Listen to what others in your breakout room have to say about the topics under discussion Express your own views on the topics under discussion in the breakout rooms Understand the purpose of the research Understand your role in the research | | | | | | |

| How much do you believe that: | | | | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|----------------------------|-------------------|-------------------|
| Definitely | To a large extent | To a moderate extent | To a small extent | None at all |
| <ul style="list-style-type: none"> Your participation was encouraged by the breakout room facilitator Your contribution was valued and respected by the other participants in your breakout room The discussions in your breakout room resulted in useful conclusions and outcomes | | | | |
| Overall, to what extent do you feel there was sufficient time made available for: | | | | |
| Way too much | Too much | About right | Too little | Way too little |
| <ul style="list-style-type: none"> Individual reflection on information and issues Discussions in the breakout rooms Presentation of information | | | | |
| Your overall experience with the presentation on Potential decarbonisation pathways: | | | | |
| Strongly agree | Tend to agree | Neither agree nor disagree | Somewhat disagree | Strongly disagree |
| <ul style="list-style-type: none"> I understood everything that was presented by the speaker I trusted what the speaker said The information presented by the speaker was relevant and helpful to the small group discussions. | | | | |
| Your overall experience with the presentation on Trade-offs and challenges for energy transitions: | | | | |
| Strongly agree | Tend to agree | Neither agree nor disagree | Somewhat disagree | Strongly disagree |
| <ul style="list-style-type: none"> I understood everything that was presented by the speaker I trusted what the speaker said The information presented by the speaker was relevant and helpful to the small group discussions. | | | | |
| Your overall experience with the Case study of decarbonisation pathways: | | | | |
| Strongly agree | Tend to agree | Neither agree nor disagree | Somewhat disagree | Strongly disagree |
| <ul style="list-style-type: none"> I understood everything that was presented by the speaker I trusted what the speaker said The information presented by the speaker was relevant and helpful to the small group discussions. | | | | |
| Your overall experience with the presentation on Energy vulnerability: | | | | |
| Strongly agree | Tend to agree | Neither agree nor disagree | Somewhat disagree | Strongly disagree |
| <ul style="list-style-type: none"> I understood everything that was presented by the speaker I trusted what the speaker said The information presented by the speaker was relevant and helpful to the small group discussions. | | | | |
| How did you enjoy your overall experience with this research project? | | | | |
| <ul style="list-style-type: none"> Very well Quite well Well Not very well Not well at all | | | | |

If the circle on the left represents you and the circle on the right represents people in your breakout room, select the diagram that best describes your relationship with the other fellow citizens in your breakout room:

| | | | | |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|  |  |  |  |  |
| Self Group | Self Group | Self Group | Self Group | Self Group |
| A | B | C | D | E |

If the circle on the left represents you and the circle on the right represents all the people in workshop, select the diagram that best describes your relationship with the other fellow citizens that attended the Zoom meeting today:



Do you have any comments or suggestions that you would like to share with us?

Demographics

Which best describes your highest level of education you have completed?

- Year 10 or below
- Year 11 or equivalent
- Year 12 or equivalent
- Trade certificate or Apprenticeship
- Certificate I or II

Which of the following best describes your occupational status?

- | | |
|------------------------|-----------------------------------|
| • Student | • Unemployed not looking for work |
| • Household duties | • Unemployed looking for work |
| • Employed – Part Time | • Retired |
| • Employed – Full Time | • Not able to work |
| | Other (please specify) |

Which occupational sector do you work in (or worked in prior to ceasing work)?

- | | |
|---------------------------------------------|------------------------------------------------|
| • Agriculture, forestry, fishing | • Financial and Insurance services |
| • Mining | • Rental, hiring and real estate services |
| • Manufacturing | • Professional, scientific, technical services |
| • Electricity, gas, water, waste services | • Administrative and support workers |
| • Construction | • Public administration and safety |
| • Wholesale trade | • Education and training |
| • Retail trade | • Health care and social assistance |
| • Accommodation and food services | • Arts and recreation services |
| • Transport, postal and warehousing | • Other services |
| • Information, media and telecommunications | • Not applicable |

In which country were you born?

- | | |
|-------------|--------------------------|
| • Australia | • New Zealand |
| • England | • Philippines |
| • India | • Scotland |
| • Italy | • South Africa |
| • Malaysia | • Vietnam |
| | • Other - please specify |

Are you of Aboriginal or Torres Strait Islander origin?

- No
- Yes, Aboriginal
- Yes, Torres Strait Islander

3. Appendix: Presentations to Citizen Panels



State of the Climate 2020

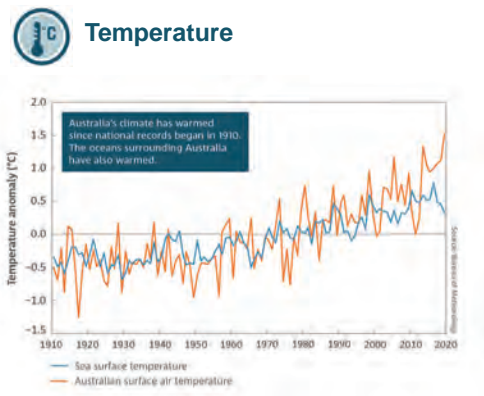
Presenter name
Greg Browning







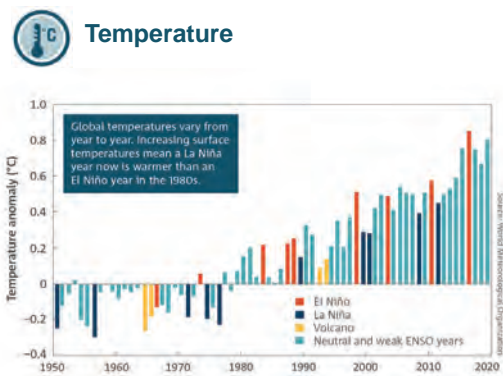
Australia's changing climate






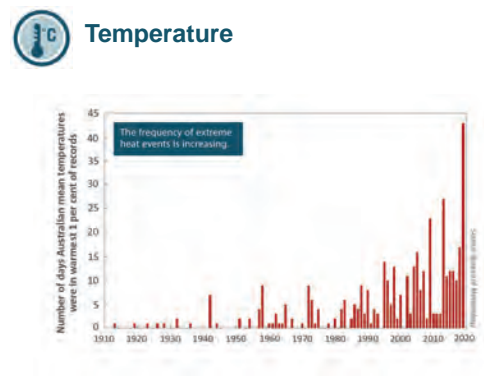
Australia's changing climate







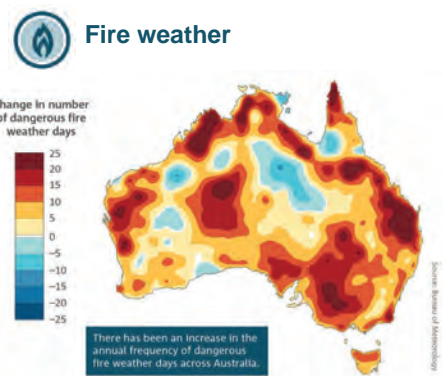
Australia's changing climate






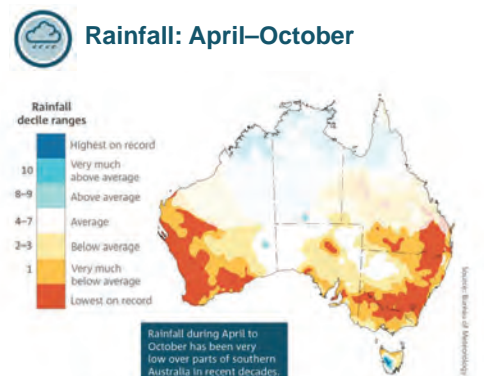
Australia's changing climate





Australia's changing climate

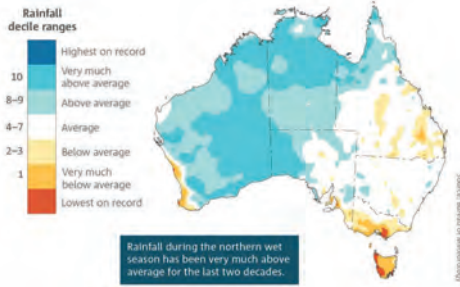




Australia's changing climate



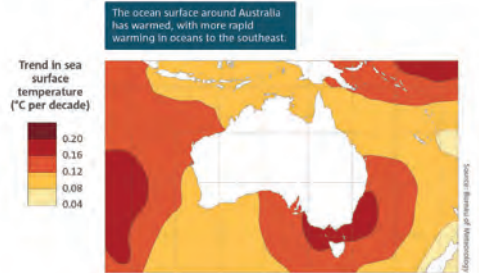
Rainfall: October–April



Oceans



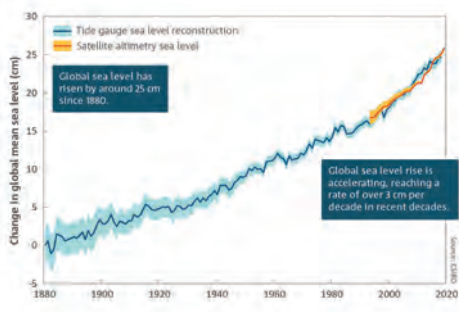
Sea surface temperature



Oceans



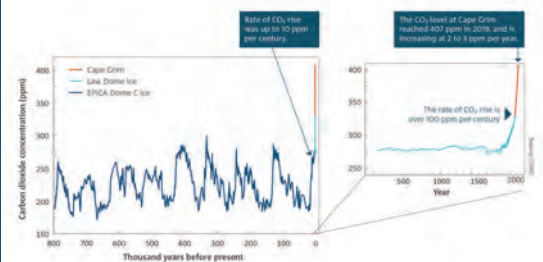
Sea level



Greenhouse gases



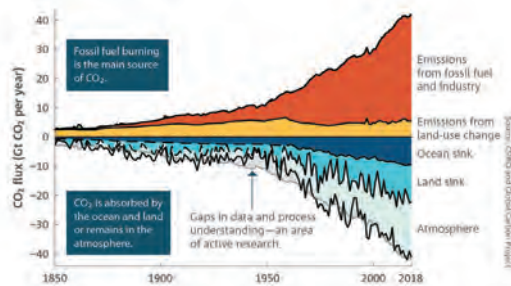
Atmospheric CO₂ concentrations



Greenhouse gases



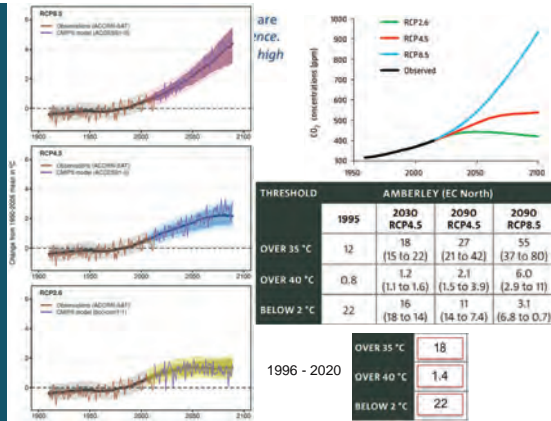
Sources and sinks of carbon dioxide



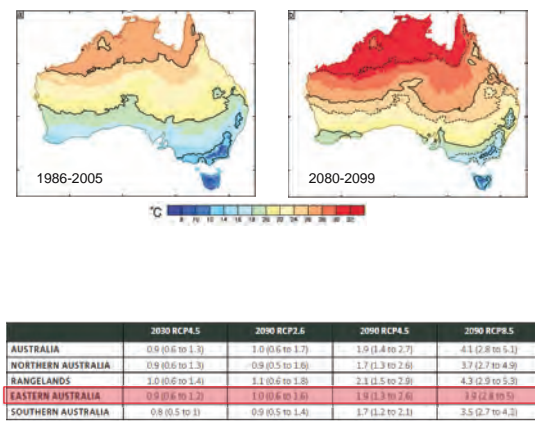
Future climate projections



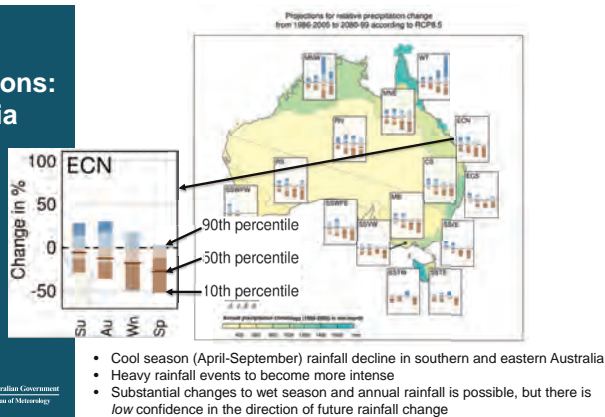
Temperature projections: Australia



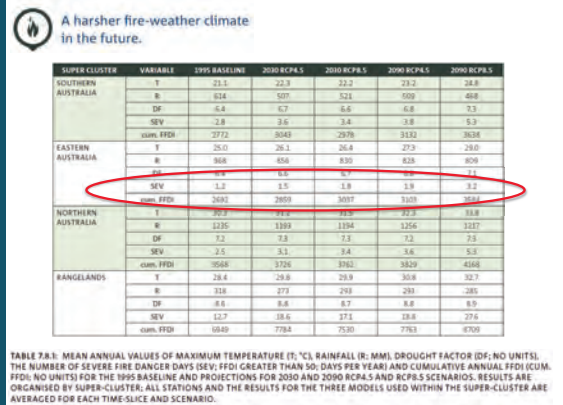
Temperature projections



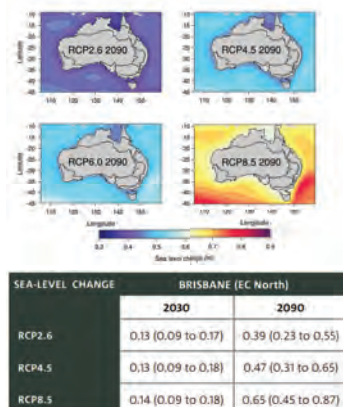
Rainfall projections: Australia



Other Projections: Fire Weather



Other Projections: Sea level



Thank you

Questions, comments?

Energy: Current State of Play

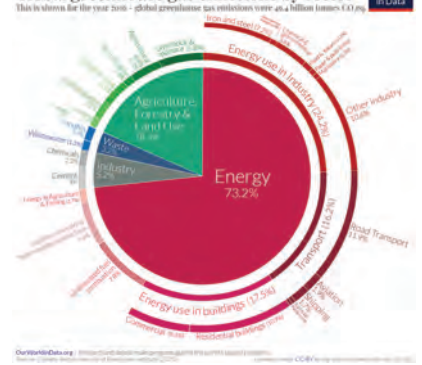
Presentation to Citizens Panels

Assoc. Professor Simon Smart
Acting Director, Dow Centre for Sustainable Engineering Innovation
22nd February, 2021

If climate change & GHG are the problem...

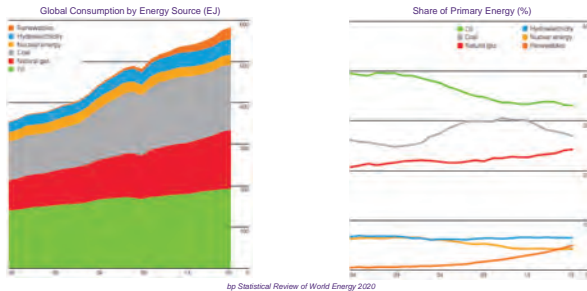
Why are we always discussing energy?

Global greenhouse gas emissions by sector

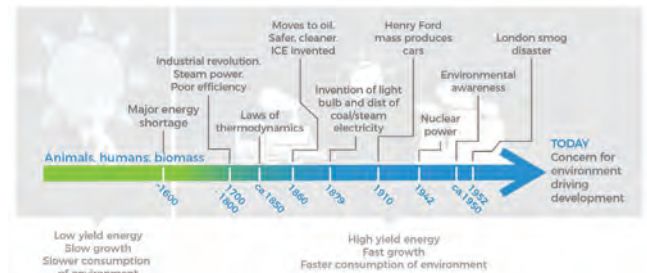


Ok, so globally are we using more or less energy?

Primary energy is the raw energy input, it is not how you see energy as a consumer



Hmm... so why do we use so much fossil energy?



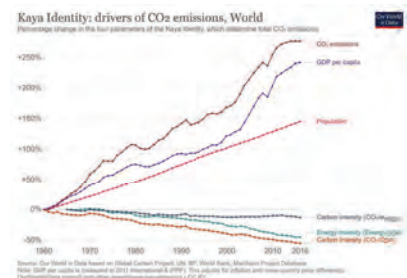
Is there another way to picture this??

How do GHG emissions relate to energy?

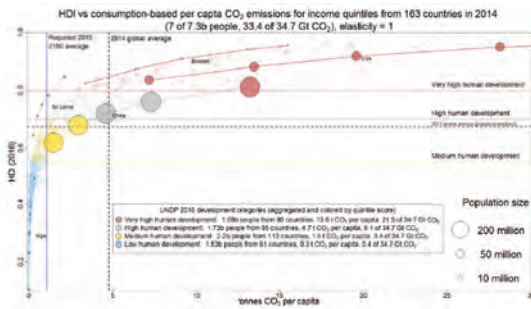
$$CO_2 = \frac{\text{Emissions}}{\text{Energy}} \times \frac{\text{Energy}}{\text{GDP}} \times \frac{\text{GDP}}{\text{Popn.}} \times \text{Population}$$

Technology Energy use Wealth

Ok, so how are we doing globally?



But, what about quality of life?



How does Australia consume energy?

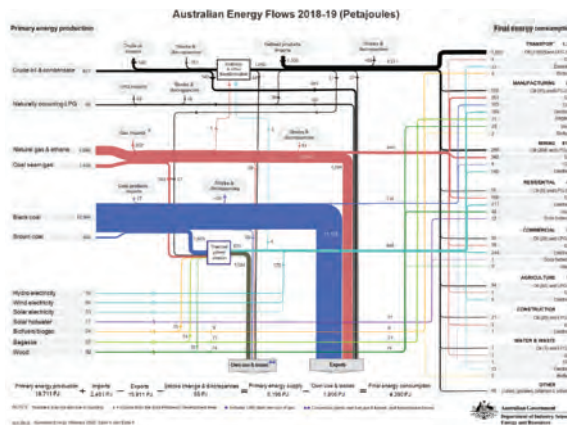


Presentation Title | Date

CRICOS code 00025B

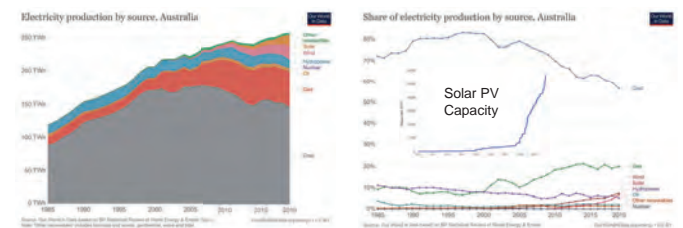
8

Australia also exports a lot of its energy...

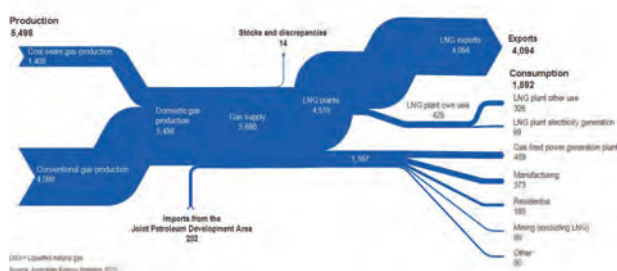


Presentation Title | Date

What does our Electricity Sector look like?



What about gas? How do we use it?



What can we look forward to?

What do the energy and emissions forecasts look like?

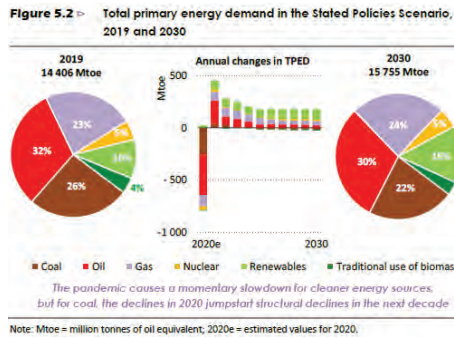
Presentation Title | Date

CRICOS code 00025B

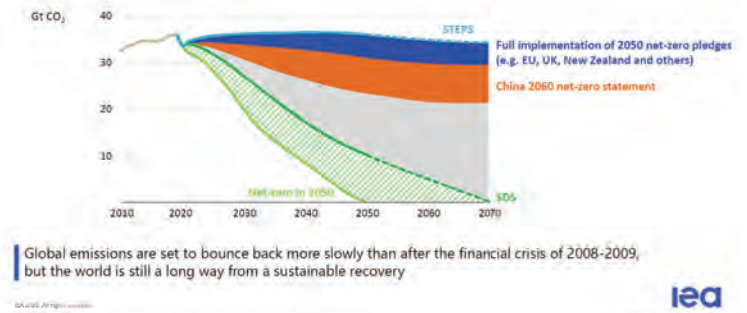
12

Primary Energy demand doesn't change much...

and neither does the share of fossil in the mix...



The world is still far from putting emissions into decisive decline



Thank you

Dr Simon Smart | Associate Professor
Dow Centre for Sustainable Engineering Innovation
School of Chemical Engineering
s.smart@uq.edu.au

facebook.com/uniofgd
instagram.com/uniofgd
@simon_k_smart
www.linkedin.com/in/simon-k-smart

CSIRO Australia's National Science Agency

Hydrogen Energy Overview

FFCRC Citizens Panel on Future fuels

Dr Patrick Hartley
CSIRO Hydrogen Industry Mission Lead
1st March 2021

What are Future Fuels?



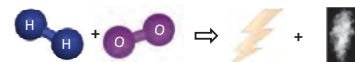
- Fuels can be solid (eg coal), liquid (eg petrol) or gas (eg natural gas)
- Almost all of our current fuels produce Carbon Dioxide (CO₂) when consumed. This is a greenhouse gas (GHG) which contributes to global warming
- Future Fuels** are being developed which have much lower or even zero GHG emissions. Various options exist:
 - Transport Fuels: renewable electricity, biofuels and **hydrogen**
 - Domestic & Industrial heating: renewable electricity, biogas and **hydrogen**
 - Power generation: renewable energy, nuclear

* Cambridge English Dictionary

Hydrogen as a Future Fuel: What is Hydrogen?

- Hydrogen, Chemical Symbol H, is the lightest and most abundant element on earth **but** only* exists on earth in chemical compounds with other elements eg with oxygen in water: H₂O or carbon in methane (CH₄ natural gas)

- Energy is needed to extract Hydrogen in its molecular form, H₂ from water and other chemical compounds
- H₂ stores this energy, and can release it when it is burnt or used in chemical reactions. The only product is water, so hydrogen can be used as an energy carrier which produces **zero greenhouse gas emissions at point of use**



- Hydrogen is already extensively used in major industries e.g. in fertilizer production

* 0.00005% in air

Where do we get Hydrogen?

From Fossil Fuels and Water



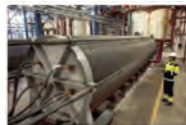
Steam Methane Reforming
 $\text{CH}_4 + 2\text{H}_2\text{O} \rightleftharpoons \text{CO}_2 + 4\text{H}_2$



From Electricity and Water: 'Water Splitting'



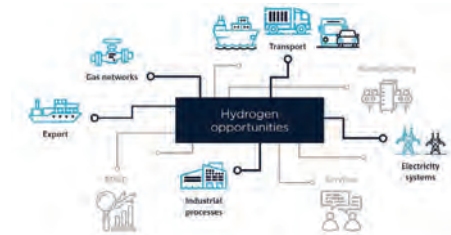
Electrolysis
 $2\text{H}_2\text{O} \rightleftharpoons 4\text{H}_2 + \text{O}_2$



4 | CSIRO Hydrogen Industry Mission | Dr P Hartley



Why Hydrogen as an Energy Carrier?

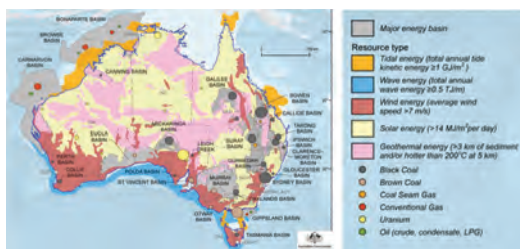


- Hydrogen can be used to decarbonize and couple diverse energy & feedstock value chains
- Establishing an Australian hydrogen industry offers additional opportunities in associated industries

5 | CSIRO Hydrogen Industry Mission | Dr P Hartley



Why Hydrogen for Australia?



- Australia has Abundant energy resources which can be used for making hydrogen

6 | CSIRO Hydrogen Industry Mission | Dr P Hartley



Why Now?

- Globally, the hydrogen industry is now underpinned by a series of mature technologies
- The costs of renewable energy have fallen dramatically making hydrogen production from these resources cost competitive for energy applications
- Emerging overseas markets for low emissions energy (eg Japan)
- The hydrogen industry narrative has shifted from technology development to market activation



7 | CSIRO Hydrogen Industry Mission | Dr P Hartley

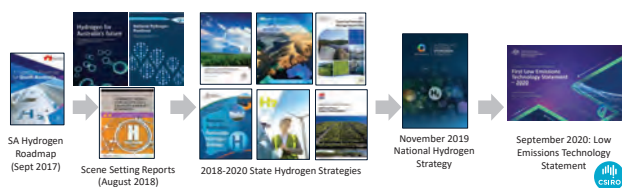


National Hydrogen Strategy Development

Council of Australian Governments (COAG) Energy Council Joint Ministerial Statement (December 2018):

"We commit to working together to develop and implement a national strategy for hydrogen, in close consultation with industry and the community"

Alignment of State, Territory & Federal Government Strategies



8 | CSIRO Hydrogen Industry Mission | Dr P Hartley



Australia's National Hydrogen Strategy (Nov. 2019)



Strategy Focus:

- Remove market barriers
- Efficiently build supply and demand
- Accelerate global cost-competitiveness
- Build an Australian hydrogen industry comprising domestic and export value chains by 2030.

Estimates that an Australian hydrogen industry could create more than 8,000 jobs and generate about \$11 billion a year in GDP by 2050.

Adopted by all federal, state and territory governments in November 2019

<https://www.industry.gov.au/data-and-publications/australias-national-hydrogen-strategy>

9 | CSIRO Hydrogen Industry Mission | Dr P Hartley



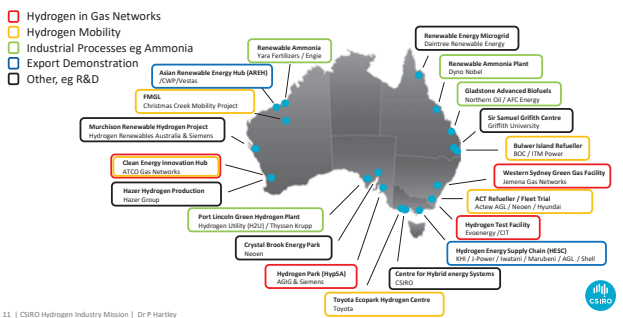
Government Investments: Hydrogen Project Support

- February 2018: South Australia Hydrogen Project Funding
 - \$17m grants & \$25m loans program
- April 2018: Victoria / Aust. Government / Japan Consortium
 - \$500m Hydrogen Energy Supply Chain Project
- September 2018: Australian Renewable Energy Agency (ARENA)
 - \$22.1m funding for 16 hydrogen research projects
- August 2019: Queensland Hydrogen Industry Development Fund
 - \$15m to support hydrogen industry projects
- March 2020: Tasmania Renewable Hydrogen Action Plan
 - \$20m Renewable Hydrogen Fund
- April 2020: ARENA Hydrogen Deployment Fund
 - \$70m towards large scale renewable hydrogen projects (electrolysis >10MW)
- May 2020: Clean Energy Finance Corporation (CEFC)
 - \$300m debt & equity Advance Hydrogen Fund
- August 2020: Western Australia Renewable Hydrogen Fund
 - \$22m to fuel WA's renewable hydrogen industry
- September 2020: Federal Govt Low Emissions Technology Statement

10 | CSIRO Hydrogen Industry Mission | Dr P Hartley



Australia's Hydrogen Demonstration Projects: Snapshot



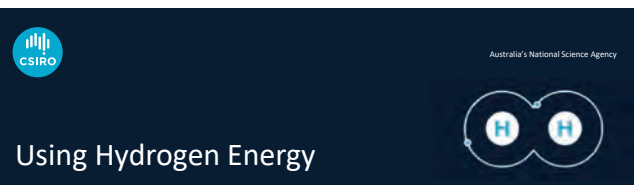
11 | CSIRO Hydrogen Industry Mission | Dr P Hartley



Thank you

Hydrogen Industry Mission
Dr Patrick Hartley
CSIRO Hydrogen Industry Mission Leader
+61 3 9545 2595
patrick.hartley@csiro.au

Australia's National Science Agency



FFCRC Citizens Panel on Future fuels

Dr Patrick Hartley
CSIRO Hydrogen Industry Mission Lead
1st March 2021

Uses of Hydrogen



- Hydrogen can be used to decarbonize and couple diverse energy & feedstock value chains
- Establishing an Australian hydrogen industry offers additional opportunities in associated industries

2 | CSIRO Hydrogen Industry Mission | Dr P Hartley



Hydrogen in Transport: Fuel Cell Electric Vehicles (FCEV)



3 | CSIRO Hydrogen Industry Mission | Dr P Hartley

Hydrogen in Transport

- Zero Emissions (CO₂, Pollution)
- High Energy Density Fuel allows Longer routes: Range similar to diesel vehicles (300-600km)
- Short refuelling (~10 mins)
- Familiar user experience
- 'Back to base' models mean less reliance on refueller networks

→ Road vehicles complementary to battery EV, choice depends on operating characteristics

Key Challenges

- Refuelling Infrastructure (Cost, Availability)
- Competing technologies eg BEV
- Vehicle Availability
- Retail Cost of Hydrogen



4 | CSIRO Hydrogen Industry Mission

Hydrogen in Gas Networks

- Hydrogen can be blended with natural gas up to ~10% and burned in existing appliances for heat to reduce overall emissions
- Australia's extensive gas distribution networks could be used to store and move hydrogen around the country

Key Challenges

- Increasing content above 10% may require changes to pipeline materials and appliances
- Hydrogen is currently high cost fuel for this application relative to natural gas



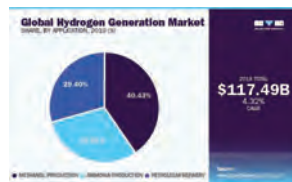
5 | CSIRO Hydrogen Industry Mission | Dr P Hartley

Hydrogen in Industrial Processes

- Hydrogen use in industrial processes is an existing large market
- Replacing existing 'dirty' industrial hydrogen demand with 'clean' hydrogen could lead to significant industry emissions reductions
- Scaling up industrial demand should lead to hydrogen supply cost reductions (economies of scale)
- Could lead to new industries such as 'Green Steel'

Key Challenges

- Switch over is capital intensive
- Innovation required for new industry opportunities to be realized (eg green steel)



6 | CSIRO Hydrogen Industry Mission | Dr P Hartley

Hydrogen in Electricity Systems

- Electrolysis & Fuel Cell technologies can 'sector couple' hydrogen with electricity systems
- Hydrogen can be stored for extended periods 'seasonal storage' cf. batteries
- Electrolysis is a flexible load which could be used to smooth out 'boom and bust' renewable energy production on the grid

Key Challenges

- Capital cost of infrastructure
- Price point of competing technologies eg batteries



<https://lavo.com.au/>

7 | CSIRO Hydrogen Industry Mission | Dr P Hartley

Hydrogen Export Partnerships

Australia has the resources and skills to build a sustainable hydrogen export industry

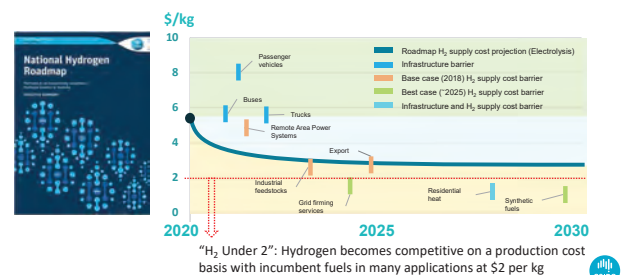
Australia's comparative advantage:

- Extensive natural resources (solar, wind, fossil fuels, CO₂ storage, available land)
- Geographical proximity
- Existing trade relationships (e.g. JAEPA, KAFTA)
- Existing Energy Resource Trade (eg LNG)
- Skilled workforce



8 | Hydrogen Industry Mission Briefing | Dr P Hartley

Costs Competitiveness Analysis: CSIRO National Hydrogen Roadmap



9 | CSIRO Hydrogen Industry Mission



Biomethane production from organic wastes

Professor Peter Ashman
Dr Tara Hosseini

School of Chemical Engineering and Advanced Materials
February 2021



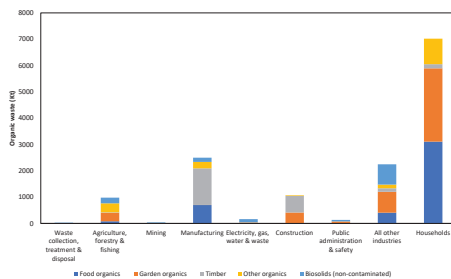
Thank you

Hydrogen Industry Mission
Dr Patrick Hartley
CSIRO Hydrogen Industry Mission Leader
+61 3 9545 2595
patrick.hartley@csiro.au

Australia's National Science Agency



Organic Waste generation



- Waste produced in Australia are 68.9 million tonnes during the year 2016-17.
- Of the total waste produced, 21.9 % (15.1 MT) are organic waste.
- Organic wastes has a potential to be converted to a green fuel called "Biomethane"

(Australian Bureau of Statistics, 2016-2017)

The University of Adelaide

Slide 2

Drivers for biomethane industry

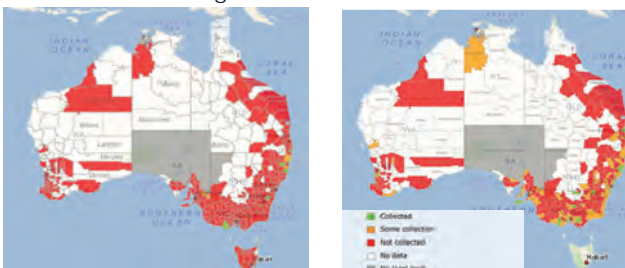
- 40% of the Australian waste is disposed to landfill because of :
 - Access to massive landmasses
 - Many abandoned open-pit mines converted into landfill
- Drivers for biomethane
 - Demand for CO₂ neutral energy production
 - Increasing electricity and gas prices
 - Rising landfill levies
 - Demand for digestate from biomethane process as soil fertilizer

(Energy Networks Australia and Bioenergy Australia, Biogas Symposium, 2019)

The University of Adelaide

Slide 3

Food/Garden Waste generation



Food waste from Kerbside Collection

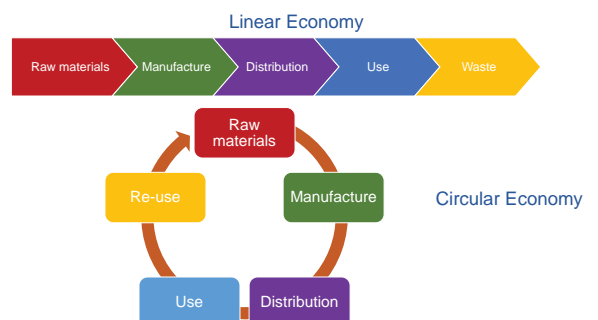
Garden waste from Kerbside Collection

(Ref: National Waste Reporting Mapping tool, Department of Agriculture, Water and Environment)

The University of Adelaide

Slide 4

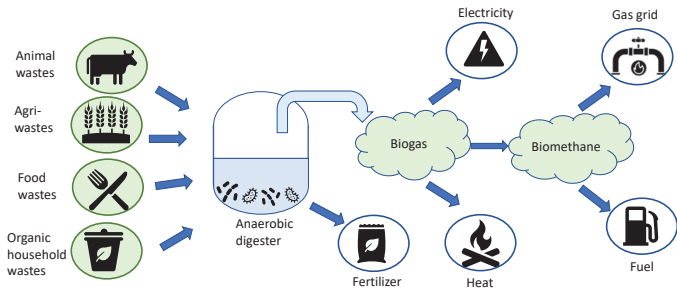
Role of biomethane in Circular Economy



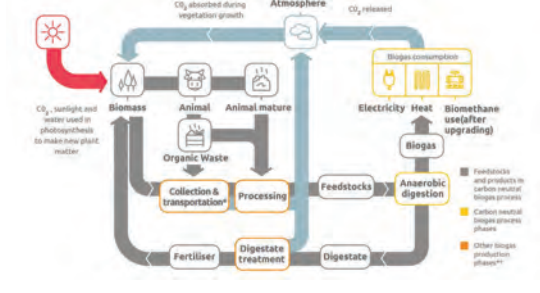
The University of Adelaide

Slide 5

How is organic wastes turned into biogas?



Biogas Plant and zero net CO₂ emission



(Biogas Opportunities for Australia ENEA Consulting – March 2019)

Biogas Production status in Australia

- The Australian biogas industry is emerging. In 2016-17, electricity generation from biogas was about 1,200 GWh.
- The total estimated biogas potential in Australia is 103 TWh which is comparable with current biogas production in Germany.
- Australia's biogas potential is equivalent to almost 9% of Australia's total energy consumption in 2016-2017
- Considering the current average size of biogas units in Australia, this could represent up to 90,000 biogas units .

(Biogas Opportunities for Australia ENEA Consulting – March 2019)

Conclusions and Summary

- Biogas is a renewable, reliable and local source of energy.
- Biogas can also be upgraded into biomethane. Biomethane can be injected into the gas grid and serve several uses for consumers such as heating, industrial purposes or fuel for gas vehicles.
- The biogas industry provides an alternative route for waste treatment while contributing to the development of local economies.
- It can be made from a large variety of organic resources, including industrial waste, agricultural waste, energy crops, sludge from waste water treatment and biowaste
- Food wastes and garden wastes have a great potential for biogas production in Australia

Thanks for your attention

Week 2 – People Experiencing Disadvantage and the Energy Transitions

People experiencing disadvantage and the Energy Transition

Future Fuels, low-carbon energy and consumers

1 March 2020

Kellie Caught, Senior Adviser Climate and Energy



Transition to clean energy necessary

Climate change and a slow, poorly managed transition is a major threat to achieving our vision to eliminate poverty and inequality

Climate change threat to eliminate poverty

- † Climate change is not only a threat to our environment, it threatens people's homes, livelihoods, health, quality of life, employment and increases risks and burdens for future generations.
- † Climate change hits people living on low-incomes or experiencing disadvantage first and hardest.
- † They have the fewest protections from climate change impacts and live in the most affected places.

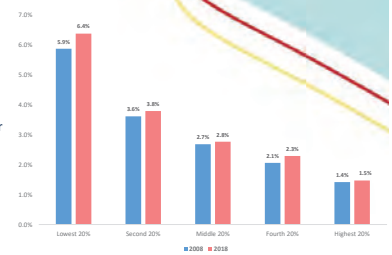
Energy Transition must be fair and equitable

- † Need a rapid transition to clean economy consistent with limiting global warming to 1.5 degrees
- † We support a more rapid transition in the energy sector because the technology is available.
- † But the transition must be fair and equitable
- † Future fuels must be consistent with warming goal and fair and equitable goal

People on low-income spend more on energy

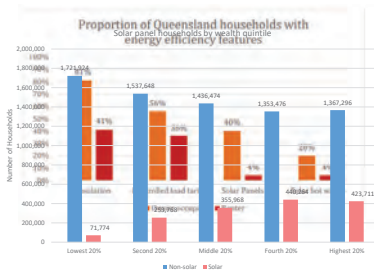
3 million people live below the poverty line

- † While electricity and gas prices increased in last decade on average bills increased from 2.3% to 2.4%
- † The lowest-income spend 6.4% of income on energy (electricity and gas), highest-income spend 1.5%.
- † One in four pay over 8.8% of income on energy, up from 7.6% in 2008.
- † About half of the cost of both your electricity and gas is for network costs.
- † People on Newstart and Youth Allowance, sole parents, lone pensioners and renters are among the most vulnerable.
- † Impacts: Deprivation or debt, Poor health, Less spending on other essentials, social isolation, Homelessness
- † Affordability = price, size of bill, capacity to pay, and access



Energy Transition – left behind

- † Higher income are able to deal with increase costs and reduce their costs
- † People on low-income have less choice and control
 - Less likely energy efficient homes and appliances
 - Less likely to have distributed energy resources like solar
 - Pay two network costs (electricity and gas) and may not be able to shift off gas or purchase new appliances.
- † People are also vulnerable due lack of access to transparent and cultural appropriate information and education
- † Risk that people on low-incomes will be left behind in the transition



Energy Transition – left behind

- † Current policies/energy market rules are exacerbating the problem
 - Some subsidies and costs being funded through energy bills
 - Most subsidies, rebates etc. are poorly targeted
 - Roll out of new technology, can be supporting harmful practices like remote disconnections
 - Non-solar owners could pay more for network costs



Gas transition for residential consumers

- † Shift to renewable hydrogen will contribute to reducing emissions
- † Renewable hydrogen good for export and large scale manufacturing, but is it right solution for residential?
- † Shifting residential properties to hydrogen gas will have cost implications:
 - Not all pipes can take 100% hydrogen and will need modifications which will add costs
 - Require households to purchase new appliances to take hydrogen
 - Households still pay network cost for hydrogen and electricity
- † There are benefits for households shifting to all electric homes
 - No longer paying for two network costs
 - Many electricity appliances are more efficient
 - Allow people to participate in new electricity services and markets, and be paid to reduce or shift electricity usage.
- † Risks
 - Stranded assets leaving vulnerable people left on a more expensive network
 - Who pays for the costs of new appliances
 - There is no accurate information on what the costs will be, no plan for a transition or understanding of who pays. The longer we delay a clearly articulated plan or transition away from fossil to electric or Hydrogen, the greater the increase in risks and costs will be for people less able to transition.

Targeted and Equitable policy

Prioritise measures so no-one is left behind

- † Improve Energy Efficiency for new and existing homes. Targeting low-income homes and renters.
- † DER subsidies and rebates should be targeted to support people on low-incomes or experiencing disadvantage.
- † Review of the role of fossil and hydrogen gas in providing clean affordable energy for residential consumers, what plans and measures need to be put in place for the changing role- particularly for people who are least able to transition
- † Innovate and reform with energy users at the centre, in particular low-income and disadvantaged households.
- † Retailers put customers at centre, fairer pricing, better hardship policies.

Policies and measures are equitable

- † Subsidies should come off bill to more progressive costs sharing like government budget
- † Reform network access and pricing rules
- † Costs of the transition should be spread equitably within the community, protect the most vulnerable and assist workers & communities in transition

Improve capacity to Pay

- † Improve energy concessions
- † Raise Jobseeker
- † Increase rent assistance





For further information contact:
kellie@acoss.org.au

Thank You





Q&A





THE UNIVERSITY
of ADELAIDE

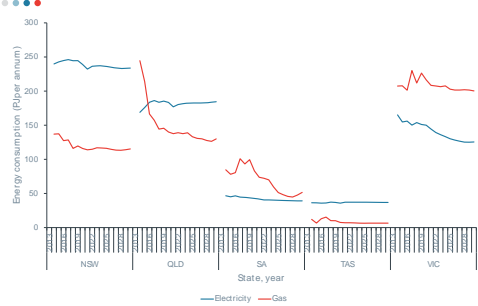


Future fuel pathways

Andrew Harpham | 15 March 2021



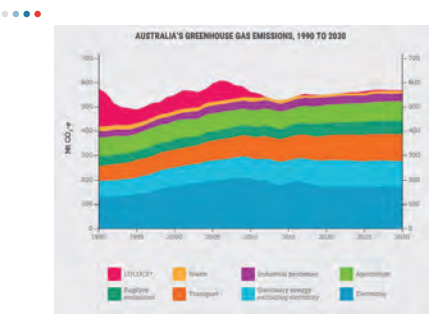
Australia currently depends on both electricity and natural gas supply



On average, Australia uses about the same amount of natural gas and electricity.

There are regional differences, reflecting availability of gas and climate.

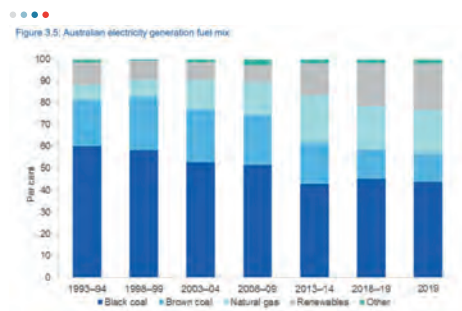
Electricity has been more emissions intensive than gas



Because so much of our electricity has been generated from coal, electricity has been a source of significant emissions.

Gas (included in 'stationary energy') is less emissions intensive.

Emissions intensity of electricity has been falling



As our electricity generation shifts more to gas and renewables, the emissions intensity of electricity has been falling.

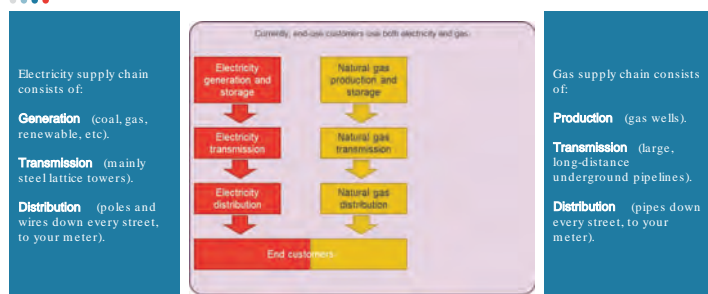
In an electricity system that is 100% renewable, there are no emissions from the use of electricity.

Reducing emissions from the use of natural gas is more challenging

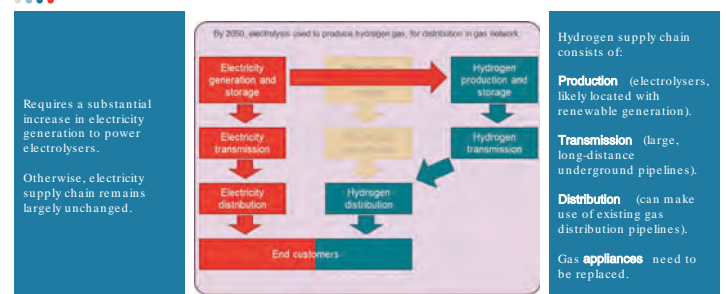
Emissions occur when natural gas is combusted in appliances. These emissions can't be avoided or captured, which means that alternative approaches to reducing emissions from this energy use are required ...

| | |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| Option 1: Hydrogen electrolysis | Switch to using hydrogen instead of natural gas. Produce hydrogen using electrolysis powered from renewable electricity. |
| Option 2: Hydrogen SMR | Switch to using hydrogen instead of natural gas. Produce hydrogen using natural gas SMR. Capture the carbon emissions from SMR, for storage or use. |
| Option 3: Electrification | Switch to using electricity instead of natural gas. Generate electricity from renewable sources. |

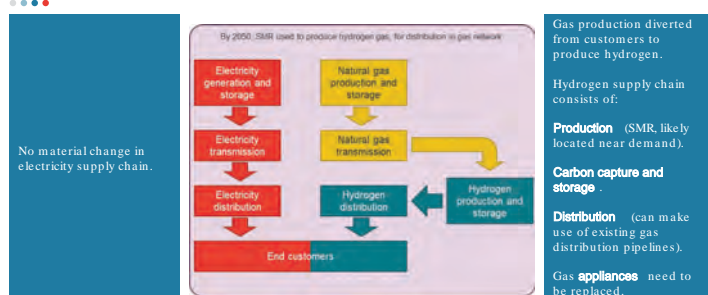
Existing energy supply chain



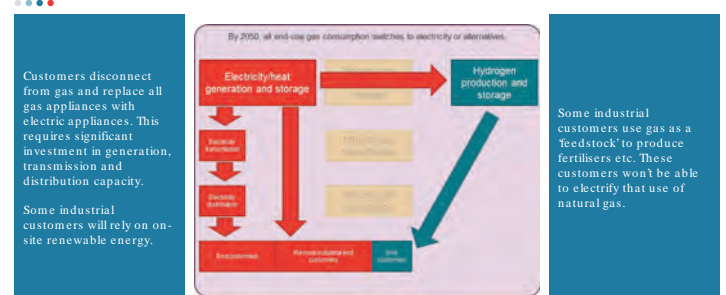
Hydrogen electrolysis – supply chain



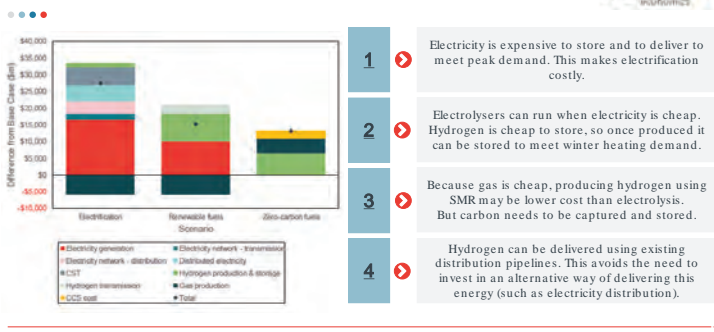
Hydrogen SMR – supply chain



Electrification – supply chain



What are the costs to society?

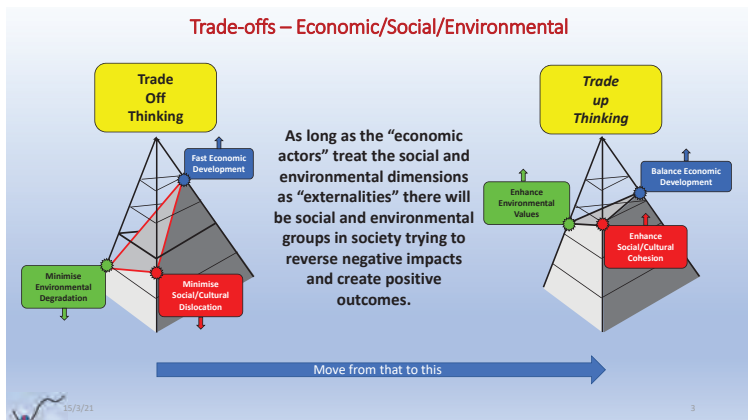
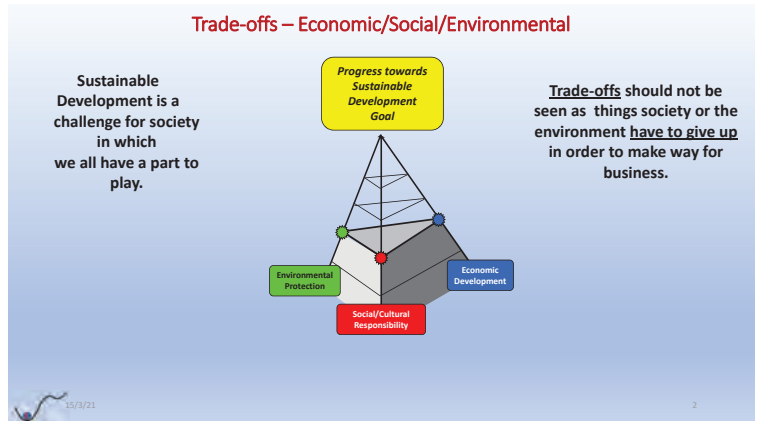
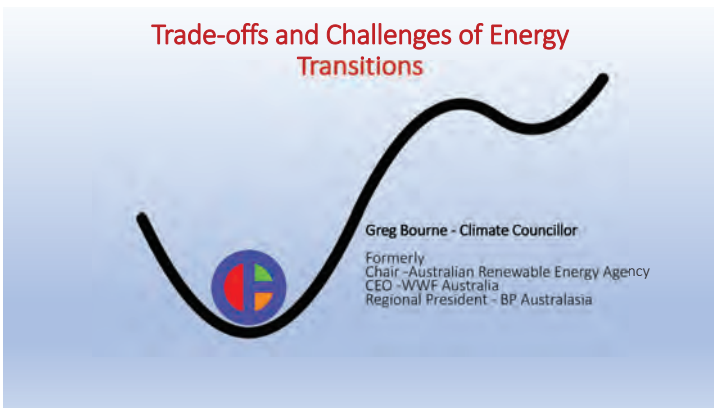


- 1 Electricity is expensive to store and to deliver to meet peak demand. This makes electrification costly.
- 2 Electrolysers can run when electricity is cheap. Hydrogen is cheap to store, so once produced it can be stored to meet winter heating demand.
- 3 Because gas is cheap, producing hydrogen using SMR may be lower cost than electrolysis. But carbon needs to be captured and stored.
- 4 Hydrogen can be delivered using existing distribution pipelines. This avoids the need to invest in an alternative way of delivering this energy (such as electricity distribution).

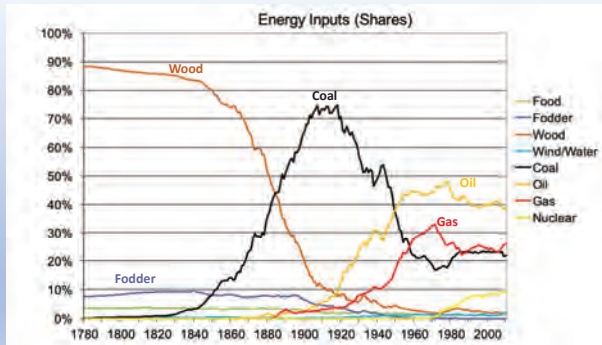
10



Week 3 – Trade-off and Challenges of Energy Transitions



Energy transitions are not new



Transitions bring change and trade-offs

All social and economic transitions come with:

- Job creation – Job losses
- Resistance to change – Acceptance of change
- Incumbent Pains – New entrant Gains
- Location of Pains – Location of Gains

Job changes affect different groups very differently!

Transitions bring change and trade-offs

Economic changes - domestic and exports

Coal phases out – Cleaner air – health benefits
Gas (Natural gas) phases down – Hydrogen phases in – Cost penalty?

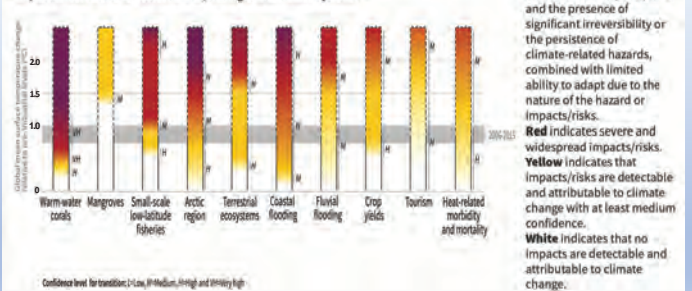
Gasoline and diesel phase out – electricity for EVs phases in – electricity bills higher, but petrol/diesel bills lower.

Less aquifer and watershed pollution and land pollution from mining and gas extraction.

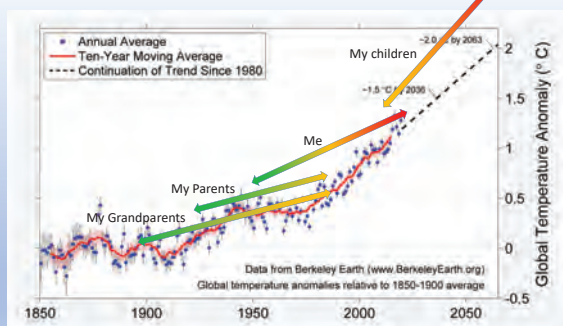
More visibility of energy generation and storage
wind, solar, batteries, pumped hydro storage

Trade-offs in the natural and social environments through inaction

Impacts and risks for selected natural, managed and human systems



Trade-offs - Intergenerational



Thank you and
questions
comments!

Net zero emissions strategy for gas assets by 2050

Energy Utility Case Study: Technology Assessment

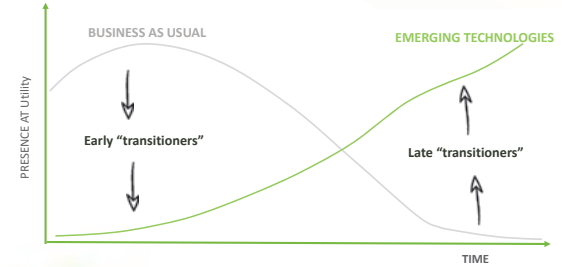
Context

- Our client needs to transition existing gas assets to align with a net-zero future, but the primary focus is finding a pathway that allows them to continue to support customers during that transition. This requires understanding the technology options and pathways available.
- We listened to key stakeholders to understand their perspective on future scenarios, to use as a framework for assessing strategic feasibility utilising the internationally recognised and verified Framework adopted by the United Nations Framework Convention on Climate Change
- Carried out techno-economic feasibility modelling of preferred pathways to quantify the costs and emissions reductions
- Progressed technical concept design of the preferred option



Change Management Journey

How do we concurrently manage priorities of today, visions of the future and the 'messy middle' in between...



...by equally valuing individuals involved at all stages in the transition.

OUTCOMES

| | Scenario GENERATION GREEN | Scenario SLEEPWALKING INTO CHAOS | Scenario HUNGER GAMES | Scenario THUNDERDOME | Average score across scenarios |
|-------------------------------------------------------------|------------------------------|-------------------------------------|--------------------------|-------------------------|--------------------------------|
| Hydrogen | | | | | |
| Option 1 100% Hydrogen Network Injection | | | | | |
| Option 2 100% Hydrogen Network Injection | | | | | |
| Option 3 Hydrogen bottled supply to residential customers | | | | | |
| Electrification | | | | | |
| Option 1 100% Electrification | | | | | |
| Option 2 Electrification up to network capacity (partial) | | | | | |
| Biomethane | | | | | |
| Remote emission reduction | | | | | |

Potential focus areas for next steps

Four zero net emission options



Remote emission reduction

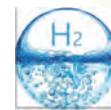
This covers two key solution options that can be used to offset residual and emissions:

- Guarantee of origin certificates
- Offsets (carbon credits)



Biomethane

The concept developed covers the identification of biomethane sources from landfill and sewage treatment.



Hydrogen

Hydrogen concepts were developed considering electrolytic production with renewables. There were three key options considered as follows:

- Option 1: 100% hydrogen network injection
- Option 2: 100% hydrogen network injection
- Option 3: Hydrogen bottled supply to residential customers



Electrification

Two electrification concepts were developed with varying assumptions around contributions to peak demand. The overall concepts were:

- 100% electrification (a) upper (b) lower
- Electrification up to network capacity, (c) partial electrification



Biomethane

The concept developed covers the identification of biomethane sources from landfill and sewage treatment in the ACT.

The potential sites for biogas capture and treatment to biomethane were:

- Lower Molonglo Water Quality Control Centre
- Mugga Lane Waste Management Centre

Mugga Lane Waste Management Centre currently has a gas to power project which has recently been awarded a new 15 year contract.

| Category | Data |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cost | New infrastructure CAPEX: \$90M (<\$100M) OPEX: \$50M (<\$10M/yr) |
| TRL / CRI | Biogas: TRL-1, CRI-1 Biogas: TRL-9, CRI-4 |
| Key risk / challenge | Existing waste streams provide only a small percentage of market need for natural gas. The ACT Waste Management Strategy to 2025 aims to reduce, reuse and recycle landfill prior to considering recovery for energy use like biomethane |
| CO ₂ impact | 4% reduction (with two identified sites but other opportunities) |



Germany

- Has 10,431 out of the 17,662 plants in Europe
- ~33PJ injected in 2016
- Levelised cost range of \$7 to \$11/GJ from energy crops, agricultural waste and biowaste

France

- Went from 1 to 47 biomethane plants between 2011 and 2017
- Various policies that helped develop the industry, including FIT, grants, loans and targets

Sustainable Sydney 2030

- > 2030 target to reduce the greenhouse gas emissions by 70% below 2006 levels
- Trigenation network can be run from 250 km radius of Sydney



Remote emission reduction

This section covers two key solution options that can be used to offset residual and emissions which are relevant to ActewAGL:

- Guarantee of origin certificates
- Offsets (carbon credits)

While there are no current existing certificates which authenticate renewable sourced gas production (for either hydrogen or biomethane) in Australia, the 2019 National Hydrogen Strategy indicates a need for the creation of guarantees of origin to enable the traceability of hydrogen production to support regulatory systems and customer choices.

| Category | Data |
|------------------------|-------------------------------------------------------------------------------------------------------------|
| Cost | OPEX: \$50M-\$100M/yr |
| TRL / CRI | TRL: dependent on technology to produce renewable gas CRI: 1 (in Australia), however 4 (internationally) |
| Key risk / challenge | Current mechanism does not exist for gas in Australia |
| CO ₂ impact | 100% (dependent on purchased/traded amount) |



Green Gas Certification Scheme, UK

The Green Gas Certification Scheme (GGCS) tracks biomethane throughout the supply chain. The GGCS tracks MWh of biomethane injected into the distribution grid and the contractual flow to avoid double-counting.



Biomethane Certification Scheme, UK

The Biomethane Certification Scheme (BMCS) is an independent certification scheme (ICST) run by Green Gas Trading Limited, a private limited company listed in the UK. The Biomethane Certificate (BMC) is an auditable guarantee of origin certificate for each MWh of gas.



Certify

Certify aims to pilot the first EU-wide green hydrogen guarantee of origin for a new hydrogen market and has a implementation roadmap for a software accreditation system / trading platform (called GO scheme).



Electrification

Two electrification concepts were developed with varying assumptions around contributions to peak demand. The overall concepts were:

- 100% electrification (a) upper (b) lower
- Electrification up to network capacity, (c) partial electrification

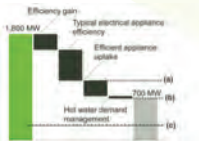
| Category | Data |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cost | <ul style="list-style-type: none"> New infrastructure CAPEX: \$1,000M - \$3,000M OPEX: 10% to 20% revenue Electrification up to network capacity Key risks: <ul style="list-style-type: none"> TRL > 9 CR: 6 |
| Key risk / challenge | <ul style="list-style-type: none"> Increased reliance on grid electricity resulting in demand management and energy storage problems Capital Cost Customer Acceptance |
| CO ₂ impact | <ul style="list-style-type: none"> 100% reduction for full electrification 17% to 24% reduction for electrification up to network capacity |



City of Berkeley - California
California shares a similar 2040 carbon neutral target to the ACT. Beginning January 2020, Berkeley will be the first US city to have natural gas for new residential connections.

The Future of Gas in Europe
Under the Paris Agreement the European Union has committed to reducing its greenhouse gas emissions (GHG) by at least 40% by 2030.

Giminderry
Will serve as a test case for an electric transition for the ACT as the first Canberra suburb without natural gas.



Hydrogen

Hydrogen concepts were developed considering electrolytic production with renewables. There were three key options considered as follows:

- Option 1: 10% hydrogen network injection
- Option 2: 100% hydrogen network injection
- Option 3: Hydrogen bottled supply to residential customers

Options 1 and 2 were further broken down into relation to their daily plant utilisation, follows:

- Option 1A & 2A: 24 hours per day electrolyser operation to meet winter demand 50% annual capacity factor for gas demand
- Option 1B & 2B: 8 hours per day electrolyser operation to meet winter demand (during solar period) 18% capacity factor for gas demand

H₂ storage considered to balance electrolyser size against 'peaky' daily winter gas demand profile as well as used for blending in network

| Parameter | Option 1 10% Hydrogen Network Injection | Option 2 100% Hydrogen Network Injection |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| Gas injection point | Gas injection point into network for 10% blending (Fyfech TRS downstream - 7 MPa) / Bungendore POTS - 1 MPa | Gas injection point into network (Fyfech TRS downstream - 14.8 MPa) |
| Category | Data | |
| TRL / CR | <ul style="list-style-type: none"> Option 1: TRL range 2, CR range 2-6 Option 2: TRL range 3-6, CR range 2-6 Option 3: TRL range 5-9, CR range 2-6 Impacted by PEM at large scale, pipeline materials compatibility, appliance compatibility, hydrogen bottles | |
| CO ₂ impact | <ul style="list-style-type: none"> 10% to 100% reduction for injection, 67% for residential bottled supply | |



Hydrogen

| Costs | Option 1 10% Hydrogen Network Injection | Option 2 10% Hydrogen Network Injection | Option 3 Hydrogen bottled supply to residential customers |
|-------|--------------------------------------------|--------------------------------------------|--------------------------------------------------------------|
| CAPEX | \$1,000M - \$3,000M | \$1,000M - \$3,000M | \$1,000M - \$3,000M |
| OPEX | \$10M - \$100M | \$10M - \$100M | \$10M - \$100M |

Key Risks shared across the options are the following:

- TRL, state of PEM technology
- Cost \$/kg H₂ from electrolyser technology
- Development approval pathway

Option specific risks are in the table below:

| Option 1 | Option 2 | Option 3 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> H₂ storage in populated area near public infrastructure Existing gas network pipeline, and customer appliance compatibility Gas network regulatory environment Hydrogen storage (safety) in populated area near public infrastructure | <ul style="list-style-type: none"> Existing gas network pipeline, and customer appliance compatibility Gas network regulatory environment Hydrogen storage (safety) in populated area near public infrastructure Residential hydrogen storage (safety) | <ul style="list-style-type: none"> Existing gas network pipeline, and customer appliance compatibility Gas network regulatory environment Hydrogen storage in populated area near public infrastructure Residential hydrogen storage (safety) |

HyOnepay Program at Keele University, UK
Aims to prove that typical appliances can be used when blending up to 20% volume of hydrogen with natural gas. From December 2020, 670 homes and businesses will take part in the next stage.

NET Leeds City Gas Project
Feasibility Study indicating feasible conversion of existing natural gas network 100% hydrogen. The peak annual gas demand for Leeds is 6.4 TWh (~23.4 PJ/a). Includes four SARN units with CCS. Total conversion cost ~£2B.

VIC network decarbonisation
Study to analyse two pathways to decarbonise Victorian gas network consumption (18.2GW or 65 TWh peak gas demand) with either full electrification or hydrogen conversion with storage options. Found the cost of hydrogen is 40% less than electrification.

Costs / TRL / CRI

Costs were broken down where possible and relevant into the following components:

- New infrastructure (greenfield construction)
- Existing infrastructure (modification/ brownfield)
- Customer cost (cost potentially borne by an end consumer)
- Operational expenses

The following CAPEX and OPEX categories were developed to assess the options.

| CAPEX range (\$M) | OPEX range (\$M/a) |
|-------------------|--------------------|
| <\$100M | <\$10M/a |
| \$100M-\$500M | \$10M-\$50M/a |
| \$500M-\$1,000M | \$50M-\$100M/a |
| >\$1,000M | >\$100M/a |

Assumptions
1. Only current demand is considered
2. Decommissioning costs are excluded

Technology (TRL) and Commercial Readiness Index (CRI)

TRL and CRI from the ARENA classification methodology have been used to describe the current view of technology maturity and commerciality

| Source: 1 - Technology Readiness Levels for Renewable Energy Systems (IRENA, 2016) | TRL | CRI |
|------------------------------------------------------------------------------------|-----|-----|
| System test, Launch & Operation | 9 | 6 |
| System / Subsystem development | 8 | 5 |
| Demonstration | 7 | 4 |
| Development | 6 | 3 |
| Research to Prove Feasibility | 5 | 2 |
| Basic Technology Research | 4 | 1 |

Hypothetical Commercial Proposition

Understanding and addressing energy vulnerability

Dr Nicola Willand
RMIT University

FFCRC Citizens Panel, 15 March 2021





What is energy poverty?

No single definition – energy/ equity/ housing/ health

Lack of access to affordable, safe, renewable and reliable essential energy services (Bouzarovski 2013; Thomson, Bouzarovski & Snell 2017; UN 2019; Bouzarovski, Petrova & Tirado-Herrero 2014)

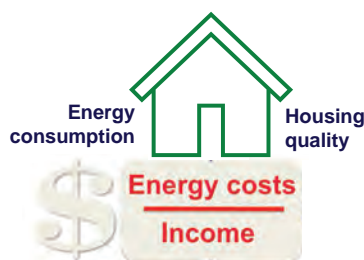
Fuel poverty = "... the inability to heat one's home to an adequate (i.e. comfortable and safe) temperature, owing to low household income and low energy efficiency" (WHO 2008)

Energy stress = "paying disproportionately more of their income on energy than the national average" (ACOSS, BSL, ANU SR&M 2018)

Energy vulnerability = intersection of risk and sensitivity to poverty and adaptive capacity (Middlemiss & Gillard 2015)

Temporary/ persistent (VCOSS 2018) **Spectrum**

How should we measure it?



"It is a societal expectation that people can heat their home to a comfortable temperature"¹

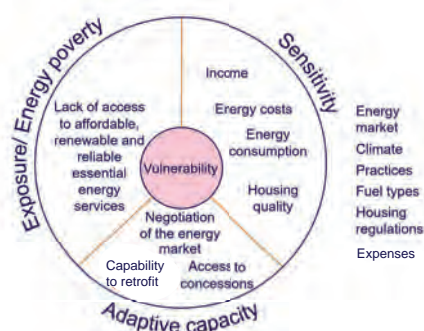


¹ Regulatory Impact Solutions 2020, Regulatory Impact Statement: Residential Tenancies Regulations 2020, <<https://engage.vic.gov.au/rentingregulations>>.

Energy vulnerability = risk of harm due to energy poverty

= Intersection of risk and sensitivity to energy poverty and adaptive capacity

Sources: Bouzarovski 2013; Middlemiss & Gillard 2015; Thomson, Bouzarovski & Snell 2017; UN 2019



How should we measure it?

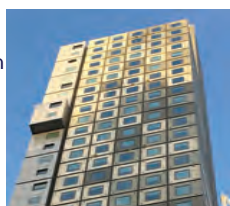
Vulnerability approach

Adaptive capacity

- Agency
- Choice
- Control
- Education
- Energy literacy
- Financial literacy
- Access to technology & information
- Dwelling characteristics
- Tenancy and consumer laws
- Negotiation of the energy market

Sensitivity

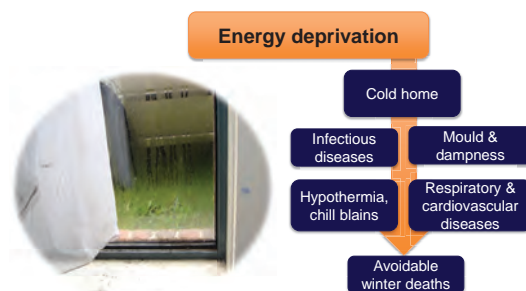
- Old and very young people
- Physiological illnesses
- Mental illnesses



(ACOSS & BSL 2019; ACOSS, BSL & ANU CSR&M 2018; ACOSS, BSL & TCI 2017; Liu & Judd 2017; Waitt et al. 2016; Willand & Horne 2018)

Why does it matter?

Because it may be a physiological health risk



(Chard & Walker 2016; Liddell & Guiney 2015; Marmot Review Team 2011; Nicholls et al. 2017)

Evidence

Studies:

Unexpected high incidence of hypothermia when staying indoors, even in summer (VIC, SA)

Risk factors:

- age >65 years,
- chronic disease,
- living on a pension,
- social isolation

(Bright et al. 2014; Forcey et al. 2019)

Photo from Pixabay

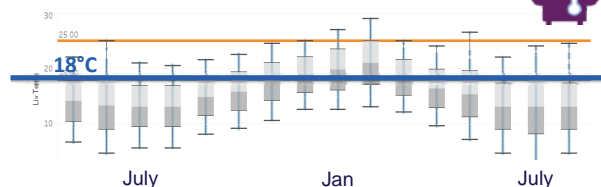


Example

Retired woman, owner occupier, living alone, Tasmania,

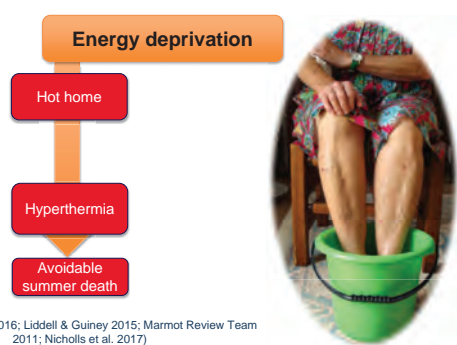
- perceived home as being uncomfortably cold,
- Went to bed early at night to keep warm (Willand et al. 2019)

→ Adequate minimum temperature threshold 18°C (WHO 2018) not achieved in any month, even in summer



Why does it matter?

Because it may be a physiological health risk



(Chard & Walker 2016; Liddell & Guiney 2015; Marmot Review Team 2011; Nicholls et al. 2017)

Why does it matter?

Because it may be a mental health risk

- Anxiety about bills
- Perceived lack of control

“Next month is going to be a shock. Because we know that in the winter we’re going to have a large bill.”

George, age 78

Because it may be social health risk

Compromising on

- Social activities
- School trips
- Job interviews that require transport

“We’re not in Probus, they go on trips... and things like that. We spent money in that, and we’ve got that in our pockets now, so that makes it a bit easier for us, with our bills.”

Larry, age 83

Why does it matter?

Because it may be a hidden problem

Some people may not seek help due to

- Pride
- Frugality
- Priorities in paying bills
- Support shifting

“I take the money off of the food to make sure the bills are paid.”

Natalie, age 69

“We’ve never had to struggle about paying our bills. We go without.”

Emily, age 85

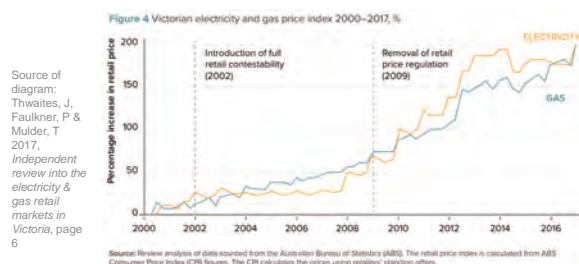


Photo by Roman Lacheev from Canva

Why does it matter?

Because the problem is likely to increase

- Energy prices are increasing more than income support
- Cost of housing is becoming more unaffordable
- More people are renting



Why does it matter?

Because the low carbon transition should not disadvantage any people

- Paris Agreement:

Parties should [...] respect, promote and consider their respective obligations on human rights, the right to health, [...] persons with disabilities and people in vulnerable situations [...] (UN 2015)

Because affordable and clean energy is a Sustainable Development Goal

- Ensure access to affordable, reliable, sustainable and modern energy for all. (UN 2019)



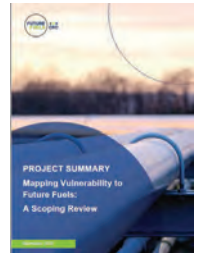
Mapping Vulnerability to Future Fuels: A Scoping Review

Role of gas in energy disadvantage and vulnerability in Australia

35 sources – little differentiation of energy carriers

! multifaceted

- individual factors - employment, health conditions, disability and age.
- external - living in rental houses and social housing, housing with poor thermal performance, inefficient technology.
- policy and market factors - gas price structures, access to retailer hardship, government support programs



Mapping Vulnerability to Future Fuels: A Scoping Review

Influence of future fuels on energy vulnerability

15 sources – mostly UK and EU, no research/data in Australia

“decarbonisation of heat” (fuel poverty)

- higher cost of energy
- cost to change appliances
- + better access to reliable energy for remote communities
- + security of energy supply through diversity
- + lower energy costs from utilising existing gas networks
- + positive opportunity costs of moving to low carbon gas



Photo by Tiana Omdarski on Unsplash

Energy vulnerability measures

Policies & programs

Local level

Individual level

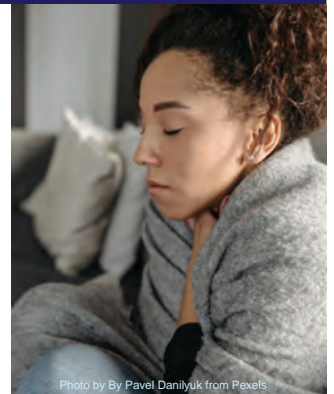


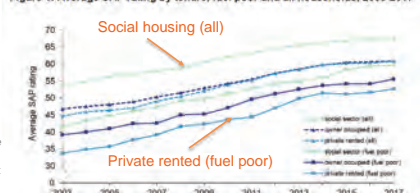
Photo by By Pavel Danilyuk from Pexels

Policies and programs

Promotion of housing energy efficiency

- Minimum energy efficiency standards for rental properties
- Target retrofit subsidies at vulnerable households (SA 100%, ACT 30%, VIC 0%)
- Ensure benefits of solar PV for vulnerable households
- Improve energy efficiency of social housing

Figure 1: Average SAP rating by tenure, fuel poor and all households, 2003-2017²



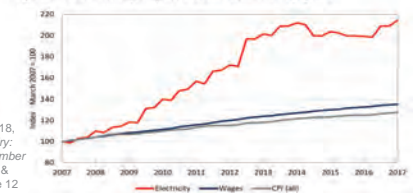
Source of diagram: BEIS 2019, Consultation on the Fuel Poverty Strategy for England, EIS Department for Business, page 9

Policies and programs

Energy concessions

- Ensure equality among states (type, amount)
- Extend beyond welfare recipients (e.g. 'working poor')
- Improve identification of eligible households
- Ensure easy application processes
- Ensure effectiveness

Figure 1.3: CPI for electricity compared with other sectors and wage growth

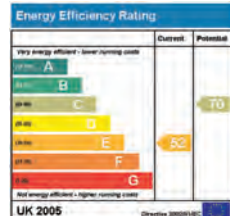


Source of diagram: ACCC 2018, Retail Electricity Pricing Inquiry: Preliminary Report, 22 September 2017, Australian Competition & Consumer Commission, page 12

Policies and programs

Information provision

- Advice on energy bills, energy practices, income support
- Tailor energy advice to individual households (language, type of home, avoid entrenching of existing curtailing practices)
- Collaborate with trusted intermediaries, e.g. community groups
- Introduce mandatory energy efficiency assessments for existing dwellings



Source of image: Gralo, via Wikimedia Commons

Policies and programs

Protection of consumers in the energy market

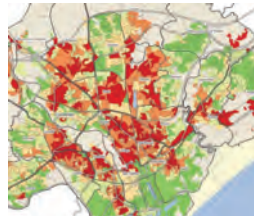
- Ombudspersons – independent complaint-handling services
- E.g. Victorian Default Offer (electricity only)
- COVID19-triggered measures in VIC:
 - No disconnection of hardship customers
 - Credit pay-on-time discount even if payment is late
 - Temporary obligation for energy retailers to check eligibility for concessions



Local level

Council-led initiatives

- Top-up subsidies, bulk-buy schemes, community education
- E.g. UK, Europe: local initiatives and collaborations
 - Identification (maps, GPs, other front-line workers)
 - Single point of referral
 - Comprehensive assistance
 - Employment of long term unemployed people



e.g. UK Poor housing map – prevalence of EPC E/F/G rated dwellings

Source of image: FRESH 2021, The FRESH Suite of Maps, Warm Wales - Cymru Gynged Cymru Buddsoddi Cymunedol, viewed 20 February 2021, <<https://www.freshwales.org.uk/mapping/maps/7on-reloaded-1>>.

Individual level

What YOU can do:

- Ensure energy efficiency in your rental properties
- Watch for hidden energy poverty
- Help family members, friends and neighbours
- National resources
 - [Energy Consumers Australia](#)
 - [Energy Made Easy website](#)
- Victorian resources
 - [Energy Info Hub](#) – resources for community workers and householders
 - [Energy Assistance Program](#)



References

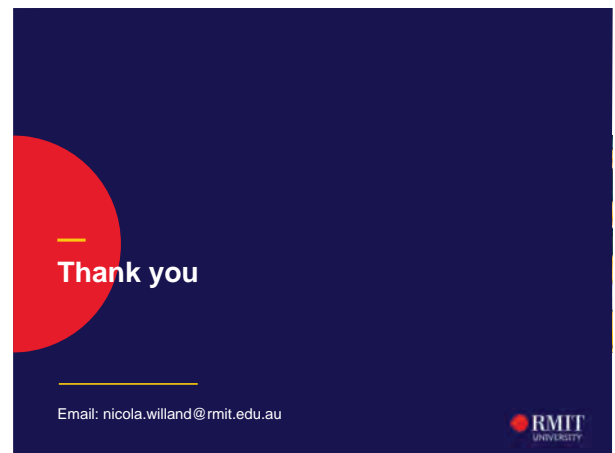
- ABS 2015, 3236.0 - Household and Family Projections, Australia, 2011 to 2036, Australian Bureau of Statistics, viewed 26 July 2018 2018, <<http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/3236.0Main%20Features42011%20to%2036>>.
- ACOSS & Brotherhood of St Laurence 2019, *Affordable clean energy for people on low incomes*, Australian Council of Social Service, <http://library.bsl.org.au/jspui/bitstream/111058/1/ACOSS_BSL_Affordable_clean_energy_for_people_on_low_incomes_2019.pdf>.
- ACOSS, Brotherhood of St Laurence & ANU Centre for Social Research & Methods 2018, *Energy Stressed in Australia*, Australian Council of Social Service, Strawberry Hills, NSW, <<https://www.acoss.org.au/wp-content/uploads/2018/10/Energy-Stressed-in-Australia.pdf>>.
- ACOSS, BSL & TCI 2017, *Empowering disadvantaged households to access affordable, clean energy*, BoSL Australian Council of Social Service, The Climate Institute, <https://www.acoss.org.au/wp-content/uploads/2017/07/ACOSS_BSL_TCI_Empowering-households.pdf>.
- AIHW Gen 2018, *People using aged care*, Australian Institute of Health and Welfare, viewed 29 August 2018, <<https://www.genagedcaredata.gov.au/Topics/People-using-aged-care>>.
- Azpitarte, F, Johnson, V & Sullivan, D 2015, *Fuel poverty, household income and energy spending. An empirical analysis for Australia using HILDA data*, Fitzroy, Victoria.
- Boardman, B 1991, *Fuel poverty: from cold homes to affordable warmth*, Belhaven Press.
- Bouzarovski, S 2013, 'Energy poverty in the European Union: landscapes of vulnerability', *Wiley Interdisciplinary Reviews: Energy and Environment*, vol. 3, no. 3, pp. 276-289.
- Bouzarovski, S, Petrova, S & Tirado-Herrero, S 2014, *From Fuel Poverty to Energy Vulnerability: The Importance of Services, Needs and Practices*, University of Sussex, Brighton.
- Bright, FM, Winskog, C, Walker, M & Byard, RW 2014, 'A comparison of hypothermic deaths in South Australia and Sweden', *Journal of Forensic Sciences*, vol. 59, no. 4, pp. 983-985.
- Castano-Rosa, R, Solis-Guzmán, J, Rubio-Bellido, C & Marrero, M 2019, 'Towards a multiple-indicator approach to energy poverty in the European Union: A review', *Energy and Buildings*, vol. 193, pp. 36-48.
- Chard, R & Walker, G 2016, 'Living with fuel poverty in older age: Coping strategies and their problematic implications', *Energy Research & Social Science*, vol. 18, pp. 62-70.

References cont.

- DECC 2012, *Fuel Poverty: Changing the framework for measurement*, UDoEc Change, <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66570/6406-fuel-poverty-changing-the-framework-for-measurement.pdf>.
- DECC 2013, *Fuel poverty statistics*, Department of Energy & Climate Change, viewed 17 February 2015, <<https://www.gov.uk/government/collections/fuel-poverty-statistics>>.
- DECC & BRE 2010, *Fuel Poverty Methodology Handbook*, <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66018/614-fuel-poverty-methodology-handbook.pdf>.
- Forsey, DS, FitzGerald, MP, Burggraf, MK, Nagalingam, V & Ananda-Rajah, MR 2019, 'Cold and lonely'. Emergency presentations of patients with hypothermia to a large Australian health network', *Internal Medicine Journal*, vol. Epub ahead of print.
- Healy, JD 2003, 'Policy review', *Housing Studies*, vol. 18, no. 3, pp. 409-424.
- Hills, J 2012, *Getting the measure of fuel poverty: final report of the Fuel Poverty Review*, London, <<http://eprints.lse.ac.uk/43153/1/CASEreport72%28series%29.pdf>>.
- Howden-Chapman, P, Viggers, H, Chapman, R, O'Sullivan, K, Telfar Barnard, L & Lloyd, B 2012, 'Tackling cold housing and fuel poverty in New Zealand: A review of policies, research, and health impacts', *Energy Policy*, vol. 49, pp. 134-142.
- Li, K, Lloyd, B, Liang, X-J & Wei, Y-M 2014, 'Energy poor or fuel poor: What are the differences?', *Energy Policy*, vol. 68, pp. 476-481.
- Liddell, C & Guiney, C 2015, 'Living in a cold and damp home: frameworks for understanding impacts on mental well-being', *Public Health*, vol. 119, pp. 1-10.
- Liu, E & Judd, B 2017, 'Tenure as barrier to low carbon living', paper presented to State of Australian Cities (SOAC) 2017, Adelaide, 28-30 November.
- Marmot Review Team 2011, *The Health Impacts of Cold Homes and Fuel Poverty*, MR Team, London.
- Middlemiss, L & Gillard, R 2015, 'Fuel poverty from the bottom-up: Characterising household energy vulnerability through the lived experience of the fuel poor', *Energy Research & Social Science*, vol. 6, pp. 146-154.

References cont.

- Nicholls, L, McCann, H, Strengers, Y & Bosomworth, K 2017, *Heatwaves, Homes & Health. Why household vulnerability to extreme heat is an electricity policy issue*, RMIT University.
- Thomas, M & Hall, A 2019, *Housing affordability in Australia*, Parliament of Australia, viewed 21 June 2019.
- Thomson, H, Bouzarovski, S & Snell, C 2017, 'Rethinking the measurement of energy poverty in Europe: A critical analysis of indicators and data', *Indoor + Built Environment*, vol. 26, no. 7, pp. 879-901.
- Tirado Herrero, S, Fernández, JLL & Losa, SM 2012, 'Fuel poverty and unemployment in Spain', paper presented to IAEE, Venice, 9 - 12 September 2012.
- UN 2019, Goal 7: *Ensure access to affordable, reliable, sustainable and modern energy for all*, United Nations Statistics Division, viewed 22 June 2019, <<https://unstats.un.org/sdgs/report/2017/goal-07/>>.
- Paris Agreement 2015.
- VCOSS 2018, *Battling On. Persistent Energy Hardship*, Victorian Council of Social Service, Melbourne, <<https://vcoss.org.au/wp-content/uploads/2018/11/Persistent-Energy-Hardship-FINAL-Web-Single-Page.pdf>>.
- Waitt, G, Roggeveen, K, Gordon, R, Butler, K & Cooper, P 2016, 'Tyrannies of thrift: Governmentality and older, low-income people's energy efficiency narratives in the Illawarra, Australia', *Energy Policy*, vol. 90, pp. 37-45.
- WHO 2008, *Closing the gap in a generation: Health equity through action on the social determinants of health. Final Report of the Commission on Social Determinants of Health*, Geneva, <http://whqlibdoc.who.int/publications/2008/9789241563703_eng.pdf>.
- WHO Europe 2007, *Large analysis and review of European housing and health status (LARES). Preliminary overview*, WROF Europe, Copenhagen, <http://www.euro.who.int/_data/assets/pdf_file/0007/1/07476/lares_result.pdf>.
- Willand, N, Ambrose, M, Watson, P & Trombley, J 2019, 'Collecting and analysing indoor temperatures for health: A review of methods', paper presented to Increasing Residential Energy Efficiency (IREE) 2019 Conference, Brisbane.
- Willand, N & Horne, R 2018, 'They are grinding us into the ground' – The lived experience of energy (in)justice amongst low-income older households', *Applied Energy*, vol. 226, pp. 61-70.



THIS PAGE INTENTIONALLY LEFT BLANK



Future Fuels CRC

Enabling the Decarbonisation of
Australia's Energy Networks



www.futurefuelscrc.com



info@futurefuelscrc.com



Australian Government
Department of Industry, Science,
Energy and Resources

Business
Cooperative Research
Centres Program